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User's Manual for EXPLORE-I: A River Basin Water Quality Model (Hydraulic Module Only)

Battelle Pacific Northwest Labs.
Richland, WA

Prepared for

Environmental Research Lab.
Athens, GA

May 82

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May 1982

USER'S MANUAL FOR EXPLORE-I: A RIVER BASIN WATER QUALITY MODEL (HYDRAULIC MODULE ONLY)

by

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Contract No. 68-03-2613

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EXPLORE-I is a computer program that simulates the dynamic hydraulic and water quality characteristics of a river basin. It can be used to study the effects of various flow conditions, waste discharges and treatment schemes on the water quality conditions of lakes, reservoirs, and estuaries. This user's manual provides input instructions for the hydraulic module of the EXPLORE-I code. Basic programming requirements of the code are also included.

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FOREWORD

As environmental controls become more costly to implement and the penalties of judgment errors become more severe, environmental quality management requires more efficient management tools based on greater knowledge of the environmental phenomena to be managed. As part of this Laboratory's research on the occurrence, movement, transformation, impact and control of environmental contaminants, the Technology Development and Applications Branch develops management and engineering tools to help pollution control officials achieve water quality goals through watershed management.

Many toxic contaminants are persistent and undergo complex interactions in the environment. As an aid to environmental decision-makers, the Chemical Migration and Risk Assessment methodology was developed to predict the occurrence and duration of pesticide concentrations in surface waters receiving runoff from agricultural lands and to assess potential acute and chronic damages to aquatic biota.

David W. Duttweiler
Director
Environmental Research Laboratory
Athens, Georgia

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ABSTRACT

EXPLORE-I is a computer program that simulates the dynamic hydraulic and water quality characteristics of a river basin. It can be used to study the effects of various flow conditions, waste discharge and treatment schemes on the water quality conditions of lakes, reservoirs, rivers, and estuaries. This user's manual provides input instructions for the hydraulic module of the EXPLORE-I code. Basic programming requirements of the code are also included.

Companion reports to this document are *Methodology for Overland and Instream Migration and Risk Assessment of Pesticides*, *Mathematical Model SERATRA for Sediment-Contaminant Transport in Rivers and Its Application to Pesticide Transport in Four Mile and Wolf Creeks in Iowa*, *User's Manual for the Instream Sediment-Contaminant Transport Model SERATRA*, and *Frequency Analysis of Pesticide Concentrations for Risk Assessment (FRANCO Model)*.

This report was submitted in partial fulfillment of Contract No. 68-03-2613 by Battelle Pacific Northwest Laboratories under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period April 1978 to January 1980, and work was completed as of January 1980.

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USER'S MANUAL

INTRODUCTION

The Battelle-Northwest (BNW) water quality model, EXPLORE-I (Baca et al., 1973a,b), is a computer program which simulates the dynamic hydraulic and water quality characteristics in a river basin. It can be used to study the effects of various flow conditions, waste discharge and/or treatment schemes on the water quality levels in the river basin.

EXPLORE-I is capable of simulating a number of hydraulic regimes in either a dynamic or steady state mode. These are:

- streams and rivers,
- shallow lakes,
- estuaries or tidally influenced rivers, and
- thermally stratified reservoirs.

In addition, the behavior of the following water quality parameters can be studied:

- Carbonaceous Biochemical Oxygen Demand (BOD)
- Nitrogenous BOD
- Benthic BOD
- Total Organic Carbon (TOC)
- Refractory Organic Carbon
- Sedimentary Phosphorus
- Soluble Phosphorus
- Organic Phosphorus
- Ammonia Nitrogen
- Nitrite Nitrogen

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- Nitrate Nitrogen
- Organic Nitrogen
- Toxic Compounds
- Phytoplankton
- Zooplankton
- Dissolved Oxygen

This user's manual is intended to provide the information necessary for application of the hydraulic module of EXPLORE-I to a river basin. A summary description of the hydraulic model used is provided to assist in understanding the code and selecting the necessary input values. Programming details of the code are also included.

GENERAL DESCRIPTION OF EXPLORE-I

The EXPLORE-I computer model consists of four computer program modules:

- hydraulic code for river and estuarine flow,
- quality code for river and estuary systems,
- hydrothermal code for thermally stratified reservoirs, and
- quality code for thermally stratified reservoirs.

The hydraulic and hydrothermal codes must be run first to provide flow and/or temperature patterns which are input information for the quality codes. The river basin codes are not coupled to the deep reservoir models, so quality profiles in impoundments must be analyzed separately.

EXPLORE-I River Basin Codes

As explained above, the EXPLORE-I river basin model consists of a hydraulic code and a quality code. The hydraulic code, which is executed first, produces a magnetic tape which contains all the necessary geometric and hydraulic data used by the quality code. This separation of hydraulic and quality calculations allows the user to set up and calibrate the hydraulic model while gathering data for the quality model.

Each of these codes has two parts, an input program and a calculation program. The results of the input programs are stored on magnetic tape for use by the calculational code. The input codes

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check the input data deck for consistency and calculate all time varying functions needed by the calculational codes. This allows the user to check his input before executing the calculational portion of the code. A diagram of the river basin code is shown in Figure 1.

The hydraulic and quality codes are set up to operate for a specified number of cycles; each calculation begins with a specific cycle and ends with a specific cycle. These are normally referred to as tidal cycles. However, the user can specify a cycle different from the tidal cycle (for example, a daily cycle) if no tidal influence occurs in the river basin being modeled. The quality code will accept two types of hydraulic input:

(1) time varying hydraulic data which in general is not cyclic in nature; and

(2) steady or cyclic varying flows.

If the user wanted to observe the effects of increased flow from an upstream source or from time varying additions and withdrawals of water from the system, option (1) would be used since these actions are not cyclic in nature. If only constant or cyclic flows (such as tidally influenced flows) were of interest, option (2) would be used. With option (2) the quality code will use the hydraulic data for one cycle again and again as it calculates the quality parameter concentrations for a number of cycles.

Since it is difficult to input all the initial velocities, depths, and flows exactly, both options allow the hydraulic code to calculate for a specified number of cycles before writing out the results of the calculations or starting to add time varying inputs. The time variables used in the hydraulic and quality codes are discussed below.

The relationship between the time bases used in the hydraulic and quality codes is most simply illustrated by time lines, as shown in Figure 2. The variables in this figure are defined as:

- **Hydraulic code time variables**

  NQSWRT = the number of the tidal cycle where printout and writing of time varying hydraulic data begin. NQSWRT refers to a segment of time rather than to a specific point in time; it is the number of the tidal cycle at which the system establishes the proper initial conditions.

  NTCYC = the number of the last tidal cycle for which the hydraulic calculations will be performed. NTCYC also refers to a time segment rather than to a specific point in time.

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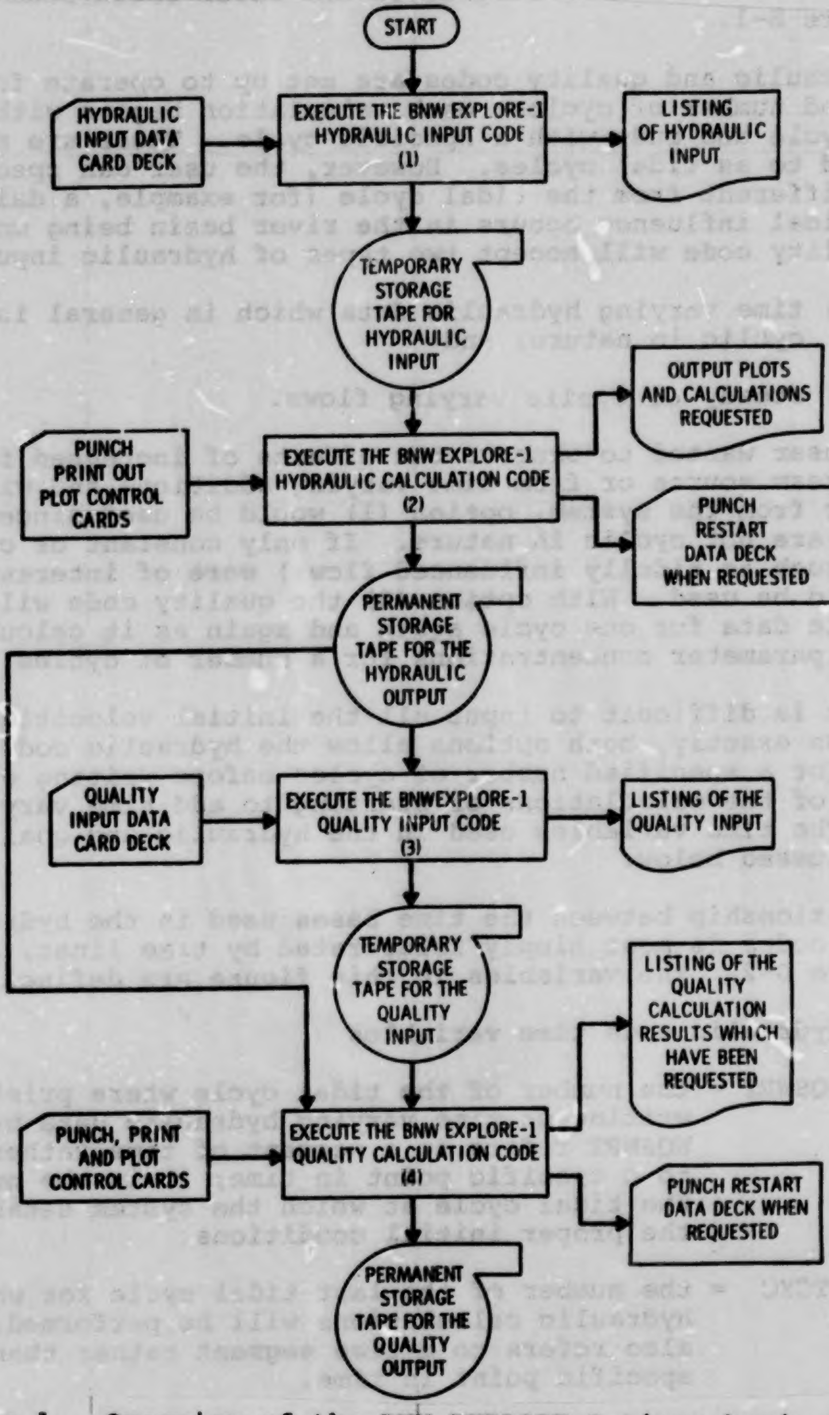
START
HYDRAULIC INPUT DATA CARD DECK
EXECUTE THE BNW EXPLORE-1 HYDRAULIC INPUT CODE (1)
LISTING OF HYDRAULIC INPUT
TEMPORARY STORAGE TAPE FOR HYDRAULIC INPUT
OUTPUT PLOTS AND CALCULATIONS REQUESTED
PUNCH PRINT OUT PLOT CONTROL CARDS
EXECUTE THE BNW EXPLORE-1 HYDRAULIC CALCULATION CODE (2)
PUNCH RESTART DATA DECK WHEN REQUESTED
PERMANENT STORAGE TAPE FOR THE HYDRAULIC OUTPUT
QUALITY INPUT DATA CARD DECK
EXECUTE THE BNWEXPLORE-1 QUALITY INPUT CODE (3)
LISTING OF THE QUALITY INPUT
TEMPORARY STORAGE TAPE FOR THE QUALITY INPUT
LISTING OF THE QUALITY CALCULATION RESULTS WHICH HAVE BEEN REQUESTED
PUNCH, PRINT AND PLOT CONTROL CARDS
EXECUTE THE BNW EXPLORE-1 QUALITY CALCULATION CODE (4)
PUNCH RESTART DATA DECK WHEN REQUESTED
PERMANENT STORAGE TAPE FOR THE QUALITY OUTPUT

Figure 1. Overview of the BNW EXPLORE-I river basin codes.

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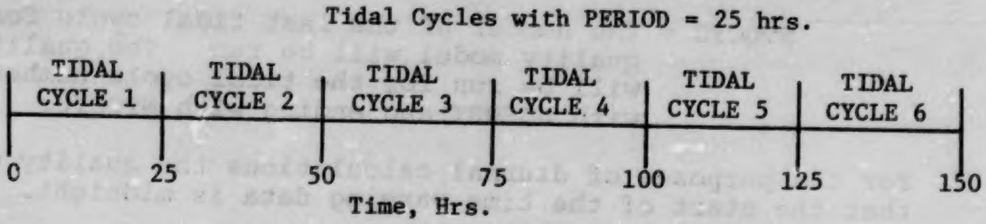
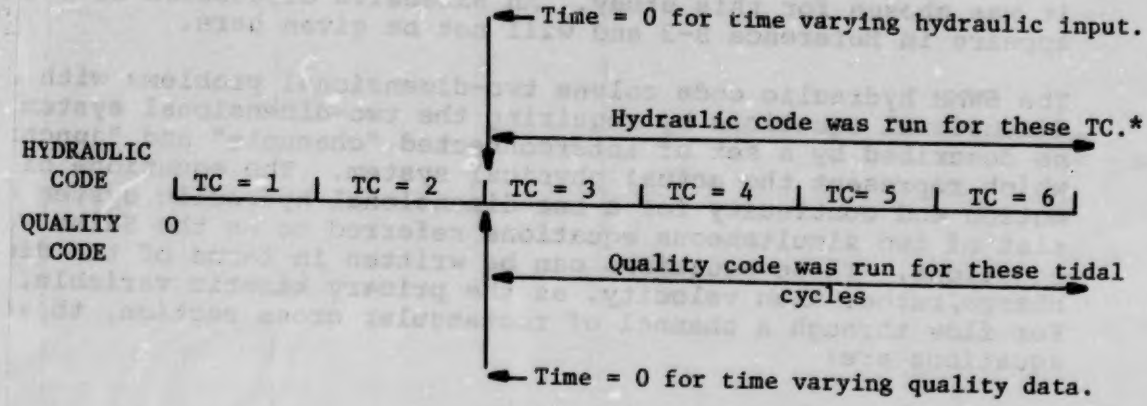
A. Time line


Tidal Cycles with PERIOD = 25 hrs.
TIDAL CYCLE 1
TIDAL CYCLE 2
TIDAL CYCLE 3
TIDAL CYCLE 4
TIDAL CYCLE 5
TIDAL CYCLE 6
0
25
50
75
100
125
150
Time, Hrs.

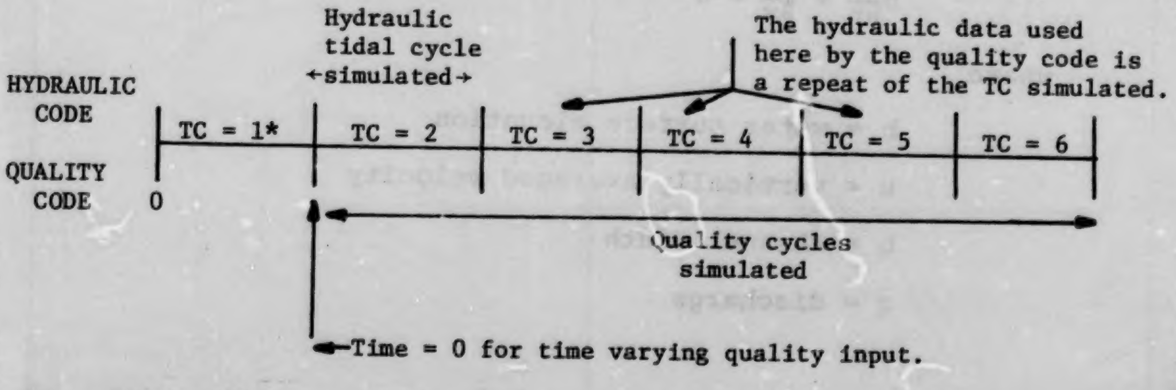
B. Time line showing NQSWRT, NTCYC, NTQCYC and zero time for the hydraulic time varying data and for the quality time varying data

(For example let NQSWRT = 3, NTCYC = 6, NTQCYC = 6, PERIOD = 25)


Time = 0 for time varying hydraulic input.
Hydraulic code was run for these TC.*
HYDRAULIC CODE
TC = 1
TC = 2
TC = 3
TC = 4
TC= 5
TC = 6
QUALITY CODE
0
Quality code was run for these tidal cycles
Time = 0 for time varying quality data.

C. Time line showing NQSWRT, NTCYC, NTQCYC and zero time point for steady state or cyclic hydraulic data

(For example let NQSWRT = 2, NTCYC = 2, NTQCYC = 6, PERIOD = 25)


Hydraulic tidal cycle ←simulated→
The hydraulic data used here by the quality code is a repeat of the TC simulated.
HYDRAULIC CODE
TC = 1*
TC = 2
TC = 3
TC = 4
TC = 5
TC = 6
QUALITY CODE
0
Quality cycles simulated
Time = 0 for time varying quality input.

*TC = Tidal cycle

Figure 2. Relationship of time base in hydraulic and quality codes.

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PERIOD = period of one tidal cycle in hours.

- Quality code time variable

NTQCYC = the number of the last tidal cycle for which the quality model will be run. The quality model will be run for the tidal cycle number starting with NQSWRT and ending with NTQCYC.

For the purposes of diurnal calculations the quality code assumes that the start of the time varying data is midnight.

HYDRAULIC CODE

The hydraulic submodel used by EXPLORE-I (Baca et al., 1973a) was originally developed for the receiving water block of the Storm Water Management Model (SWMM) by Water Resource Engineers (WRE). Because the SWMM hydraulic model has been previously applied successfully to various problems, Water Resources Engineer (1966), Callaway et al. (1969), Metcalf and Eddy (1971), it was chosen for this study. An extensive discussion of the theory appears in Callaway et al. (1969) and Baca et al. (1973a) and will not be given here.

The hydraulic code used by EXPLORE-I solves two-dimensional problems with one-dimensional equations by requiring the two-dimensional system to be described by a set of interconnected "channels" and "junctions" which represent the actual physical system. The equations of motion and continuity for a one-dimensional hydraulic system consist of two simultaneous equations referred to as the Saint Venant equations. These equations can be written in terms of the discharge, rather than velocity, as the primary kinetic variable. For flow through a channel of rectangular cross section, these equations are:

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + g\frac{\partial h}{\partial x} - gS_o + gS_f - gS_w = 0 \qquad (1)$$

and

$$b\frac{\partial h}{\partial t} + \frac{\partial q}{\partial x} = 0 \qquad (2)$$

where

g = gravitational acceleration

h = water depth

u = vertically averaged velocity

b = channel width

q = discharge

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S_o = bottom slope

S_f = friction slope due to bed shear stress

S_w = friction slope due to wind stress

t, x = time and space coordinates, respectively.

The code uses a modified set of one-dimensional Saint Venant equations to model the two-dimensional flow in an estuary or river basin by superimposing on the estuary or river basin a grid of junctions and channels. Only one-dimensional flow is then allowed in the channels connecting the junctions. Each junction in the system is a water and potential energy storage element which is characterized by its (1) surface area, (2) water surface elevation, (3) bottom elevation, and (4) the actual (X,Y) coordinates of the junction points. The water storage of the basin or estuary is represented by this series of junctions. Flow between these junctions is through rectangular channels which connect the junctions. A channel is described by its (1) length, (2) width, (3) Manning coefficient, (4) average bottom elevation at the midpoint, and (5) the junction numbers which lie at its end points.

Thw two Saint Venant equations are not solved simultaneously for this system. Instead, the one-dimensional equation of motion, Equation 1, is solved for each of the channels in the system on the basis of the present values of the junction heads. Velocity and flow in each of the channels are thus determined. Next, the modified equation of continuity, Equation 3:

$$A_{sj} \frac{\partial h_j}{\partial t} = \sum_{i=1}^{k} Q_i + \left(Q_j^{im} - Q_j^{ex} - Q_u^{ev} \right) \tag{3}$$

where

A_{sj} = surface area associated with the junction j

Q_i = flow of a channel i connectivy to the junction j

Q_j^{im} = water importation rate to the junction j (source term)

Q_j^{ex} = water exportation rate from the junction j (sink term)

Q_j^{ev} = evaporation rate

is solved for each of the junctions on the basis of the predicted flows in each of the channels. This process is repeated for the duration of the simulated time period.

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Hydraulic Data Input Information

An example of the nodalization of a river basin is shown in Figure 3. The selection of junctions and channel locations and the necessary data for each is discussed below.

Junction Data. The selection of junction points and the distances between them are determined by a size of a time step desired for running the hydraulic model. For a large problem a time step greater than 100 seconds would generally be used. For most estuaries and large rivers (say, flows greater than a few thousand cfs), the maximum time step, Δt, which can be used for a given channel length, L, is determined approximately from

$$\Delta t \lesssim \frac{L}{\sqrt{gR}} \qquad (4)$$

where

R = the hydraulic radius ($R \doteq$ average water depth) of the channel

L = length

g = gravitational constant

Figure 3 shows the initial nodalization of a sample river basin. After running the model, the user might wish to add new junctions, change the locations of junctions, or remove junctions to improve the simulation results.

Figure 4 is a worksheet which can be used to gather the data necessary to describe the junctions. As indicated on the worksheet, and described in succeeding paragraphs, hydraulic data are required for:

1) the average water surface elevation for the junction point,

2) the water surface area associated with the junction point,

3) any significant inflows to the junction point from small streams, tributaries or other sources,

4) any significant outflows from the junction point,

5) the average elevation of the bottom of the river or estuary for the junction point, and

6) the cartesian coordinates of the junction point (necessary only if the effect of wind stress on channel flow is being

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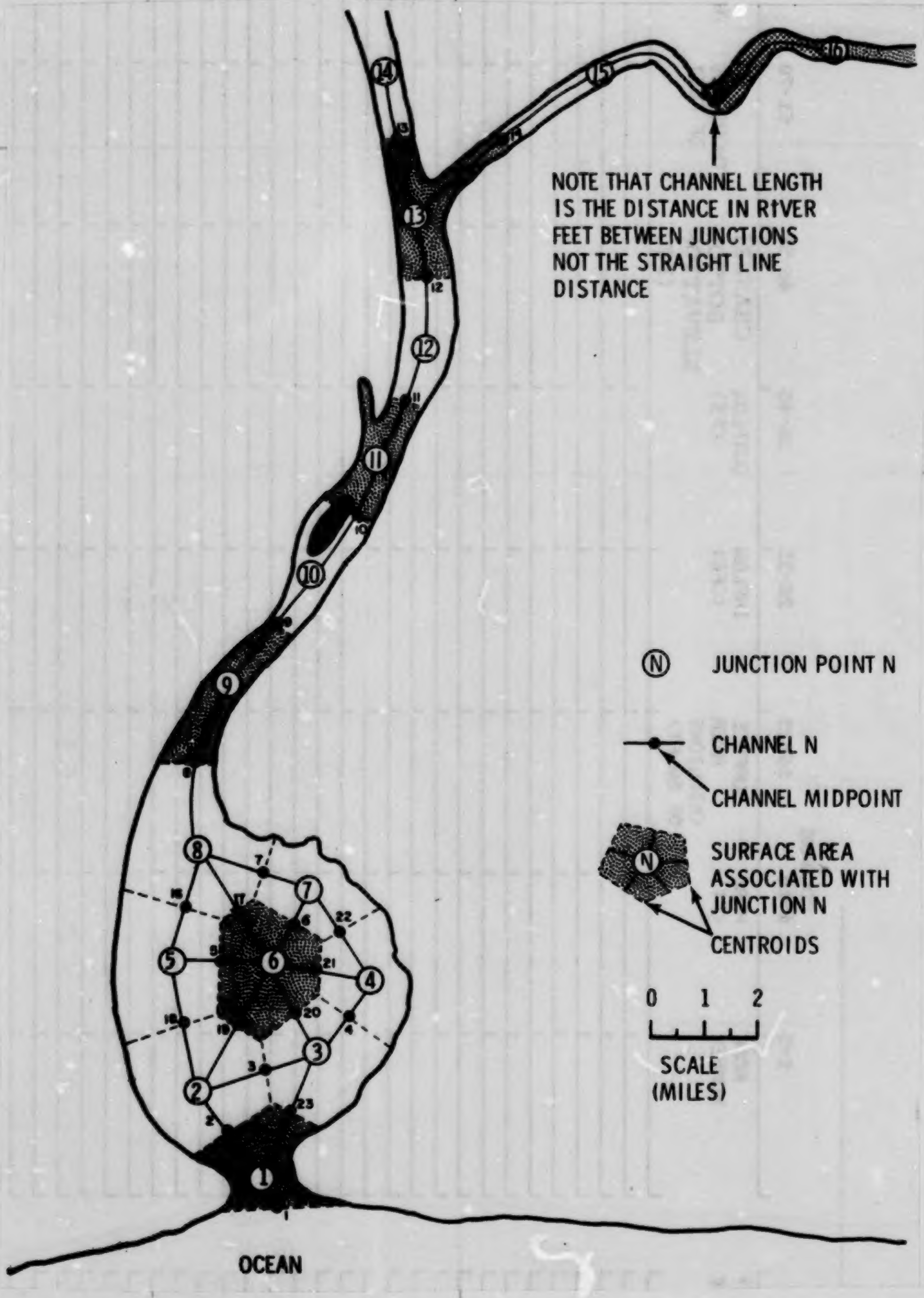
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19
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3
2
23
2
1
1
OCEAN
Ⓝ JUNCTION POINT N
CHANNEL N
CHANNEL MIDPOINT
N
SURFACE AREA ASSOCIATED WITH JUNCTION N
CENTROIDS
0 1 2
SCALE (MILES)

NOTE THAT CHANNEL LENGTH IS THE DISTANCE IN RIVER FEET BETWEEN JUNCTIONS NOT THE STRAIGHT LINE DISTANCE

Figure 3. A sample river basin.

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JUNCTION DATA
RIVER(OR STREAM) ______________

COLUMNS

		1-5	6-15	16-25	26-35	36-45	46-55	61-70	71-80
River Mile	Input Source	Node Number	Head (m)	Surface Area (sq. km)	Inflow (m^3/sec)	Outflow (m^3/sec)	Channel Bottom Elevation (m)	X Thousands of meters	Y Thousands of meters

Figure 4. Worksheet for gathering input data to describe the problem's junction points.

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calculated).

The water surface elevations need only be a reasonable guess, as the code will predict the correct head after the simulation has run a day or two. The initial head can be determined from the elevation (taken from topographic maps), by adding the known water depth at the junction point to the known elevation of the river or estuary bottom, or from other sources (e.g., Corps of Engineers records, if available).

The surface area of a junction is bounded by the lines which connect the centroids of adjacent areas. Figure 3 illustrates the method of determining the surface area of a junction for almost any kind of junction point. The surface area can be obtained by planimetering topographic or navigation maps. Junctions with tributary inflows which are not modeled should be accounted for by a representative surface area.

Inflow rates for tributaries or streams which are not modeled but contribute a significant amount of water into the junction should be specified. Outflow rates for unmodeled outflows should also be specified.

The average elevation of the river or estuary bottom for the junction point can be determined from

- physical measurements;
- navigation charts or topographic maps which give sounding contours for the river or estuary (any good method of averaging this data can be used to determine the average junction point's bottom elevation; see Callaway et al. (1969) for one method; and
- data (such as from the U. S. Corps of Engineers) available on average water depth versus river mile (the area under this curve can be integrated and divided by the channel length to determine the average water depth for the junction).

The cartesian coordinate system used to define the (X,Y) values must be a right-hand coordinate system, i.e., the positive Y axis must point north.

Channel Data. Figure 5 is a worksheet which can be used to gather the data necessary to describe the channels. As indicated by the channel worksheet and described below, hydraulic data must be gathered for:

1) channel length,

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CHANNEL DATA
RIVER(OR STREAM) ____________________

COLUMNS

1-5	6-10	11-15	26-35	36-45	46-55	56-65	66-75
Channel Number	Junction at Lower End of Channel	Junction at Upper End of Channel	Length of Channel (m)	Width of Channel (m)	Average River Depth (m)	Manning Coefficient	Initial Velocity (m/sec)

Figure 5. Worksheet for gathering input data to describe the problem's channels.

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2) channel width,

3) average elevation of the channel bottom,

4) Manning coefficient for the channel, and

5) initial velocity in the channel.

The length of a channel is simply the distance in river meters between the two junction points which lie at either end of the channel (see Figure 3).

The channel width is the average surface width of a river or tributary channel or the distance between centroids of adjacent areas for an estuary channel (see Figure 3).

The average elevation of the channel bottom can be estimated as the average of the bottom elevations of the junctions at the ends of the channel.

If actual measurements are not available, the Manning friction coefficient for the channel can be estimated from Table 1 below.

Table 1. A Tabulation of Representative Values of the Manning Friction Coefficient for Various Types of River Channels (Henderson 1966)

Natural River Channels	
Clean and straight	0.025-0.030
Winding, with pools and shoals	0.033-0.040
Very weedy, winding, and overgrown	0.075-0.150

The initial velocity must be supplied only for channels where a stability problem might exist. Flow and velocity in the channels are positive when the flow in the channel is from a low junction number to a high junction number. In an estuary or large river where the channels are more likely to be stable, 0 can be input for the initial velocity.

Controlled Nodes and Upstream Boundary Conditions

The solution of the hydraulic problem requires two driving functions:

- a time varying function to control the head or outflow for the downstream end point junctions (controlled nodes), and

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- an upstream constant or time varying flow input for the upstream end point functions.

For the sample river system in Figure 3, constant or time varying inflows would be specified for upstream junctions 14 and 16 and a stage versus time history would be supplied for the downstream controlled node 1.

Constant inflows to upstream end point junctions are simply specified as inflows on the junction data sheets (see Figure 4). Time varying upstream inputs are handled as indicated below.

Controlled Nodes. Controlled nodes, which are required at every downstream boundary in the river system, specify the boundary conditions. When simulating an entire river basin it is likely that points of discontinuity such as dams, waterfalls and locks will occur in the hydraulic system. These are not downstream end points but they must be controlled as if they were. The original structure of the SWMM code would have required simulation of each portion of the river basin lying between two discontinuities as a separate problem. The modified code used here nodalizes the entire river basin to include these discontinuities and locates a controlled junction at each point where flow or head is to be specified. An associated controlled channel must connect this controlled junction with the next downstream junction.

Use of the controlled nodes and channels must conform to the following rules:

- **Controlled junctions must be numbered first; for instance, if there are N controlled junctions in the system they must be numbered as junctions 1 through N.**
- **Each controlled junction (except a tidally influenced one) must have only downstream flow.**
- Each controlled junction must have only one controlled channel connecting it downstream to another junction (or seaward, with no junction, in the case of a tidally influenced junction). The controlled channel must be assigned the same number as the controlled junction with which it is associated.
- **No two controlled nodes can be directly connected by a channel.**

Except for these restrictions, numbering of nodes and channels can be carried out in any order.

Six types of controlled nodes are allowed. They are:

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1) a weir type, in which the flow over the weir and out of the controlled node is determined by the formula

$$Q = A_1(H-A_2)^{A_3} \tag{5}$$

where

Q = flow, m^3/sec

H = water surface elevation upstream of weir, m

A_1 = weir coefficient

A_2 = elevation of weir, m

A_3 = weir exponent

2) a tidally controlled node at which the stage versus time history is specified;

3) a Q versus H dam, where outflow is controlled as a function of the dam upstream water surface elevations [the user inputs an array of (H,Q) points which are fit by polynomial regression to form a function to predict Q for any value of H];

4) a dam at which head and outflow are both known functions of time [the user supplies an array of (t,Q) points and an array of (t,H) points; these arrays are fit by polynomial regression and two time functions are formed, one to predict Q as a function of time and one to predict H as a function of time];

5) a dam at which head is a known function of time [the outflow from the dam is determined via a mass balance; an array of (t,H) points is supplied by the user and a polynomial function is fit to these data points]; and

6) a dam at which outflow is a known function of time and head must be determined from a mass balance [an array of (t,Q) points is supplied and a polynomial fit of the data is performed].

Time Varying Inflows or Upstream Hyraulic Inputs from Discharge Hydrographs. The user can specify time varying inflows to any junction in the system by indicating the number of time varying inputs and an array of junction numbers where these inputs are to be added. In addition, the user must supply an array of (Q,t) points for each input where Q is the discharge and t is time. These arrays are then fit via polynomial regression and functions are formed so that the inflow or outflow can be

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predicted for any time.

Evaporation and Wind Stress. If in the river basin being simulated evaporation or wind can significantly affect flow patterns or water quality, the gross effects of these factors can be accounted for. The user can supply an evaporation rate in (inches/month) and the average wind speed and direction for the entire basin.

Tributary Channels. The original SWMM hydraulic code was modified to allow the marking of "small tributary channels" which became necessary at every junction between a large river and a small tributary (Baca et al., 1973a,b). The original code calculates the hydraulic radius of a channel by averaging the characteristics of the nodes at the ends of the channel. In a single river or an embayment all of the channels have similar characteristics and this is a valid estimation. However, at the junction between a large river and a small side tributary the characteristics of the small tributary channel are grossly overestimated by averaging the properties of the nodes at the channel ends. The properties of the channel are most like those of the first upstream node in the tributary (except when backflow to the tributary is allowed). The changes in the hydraulic code allow the user to mark the small tributary channels and associate with each of these channels the characteristics of the first upstream node in the small tributary. The revised code then simply calculates the channel properties for the small tributary channel on the basis of the properties of the marked upstream node. If there is backflow to the tributary, channel properties are calculated in the normal manner.

Hydraulic Input Data Deck Preparation

After the river-estuary system has been nodalized as described above and the data sheets for the junctions and channels have been prepared, the input data deck is prepared. As mentioned above and in the following section, the hydraulic code consists of two separate executable programs, an input code (IMAINT and associated subroutines) and a calculation code (HMAINT and associated subroutines). Table 2 and Figure 6 indicate the input data format and the relative order of the input card deck required for running IMAINT, the input code. Modifications in Table 2 from the 1973 version of EXPLORE-I include a change from English to metric units for all variables, a maximum value for the number of data points used in defining the time varying function (see data group H9), and an additional variable, HYDEND, in the hydrograph input requirements (see data group H10). Input variables in metric units are converted to English units within the program. An additional input modification noted in the text includes the requirement of assigning the same number to a controlled node and to its associated controlled channel.

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Table 2. Data Card Format for EXPLORE-I Hydraulic Input Code

Card Group	Format	Columns	Description	Variable Name	Default Value
H0	15A4	1-60	Title for run (card 1)	ALPHA (1-15)	none
	15A4	1-60	Title for run (card 2)	ALPHA (16-30)	none
			Hydraulic control card		
H1	I5	1-5	Number of the last tidal day cycle to be simulated	NTCYC	none
	3F5.0	6-10	Number of hr/tidal day cycle	PERIOD	none
		11-15	Length of quality time step, hour (must be evenly divisible into PERIOD)	QINT	none
		16-20	Length of hydraulic time-step, second (must be evenly divisible into QINT)	DELT	none
	5X				
	3F5.0	26-30	Evaporation rate (mm/month)	EVAP	none
		31-35	Wind velocity, m/sec	WIND	none
		36-40	Wind direction, clockwise, degrees from North	WDIR	none
	4I5	41-45	Tidal day number where printed output will start and the quality tape will be prepared	NQSWRT	none
		46-50	Number of junctions with time varying inflow	NJSW	none
		51-55	Number of controlled junctions	NJGW	none
		56-60	Number of tributary channels	NTRIB	none

Table 2. (continued)

Card Group	Format	Columns	Description	Variable Name	Default Value
			[Junction numbers where hydrograph inflows are present]		
H2	I5	1-5	Junction number where first hydrograph inflow is present	JSW(1)	none
	I5	6-10	Junction number where second hydrograph input is present	JSW(2)	none
	. . .	. . .		. . .	. . .
			Junction number where last hydrograph input is present	JSW(NJSW)	none
			[Codes which indicate the type of controlled node (a number from 1-6) 1 means weir relationship (A1, A2, A3 needed) 2 means tidally influenced 3 means dam operated from Q vs H curve 4 means dam head and outflow determined from H vs t and Q vs t curves 5 means only dam head determined from H vs t curve 6 means only dam outflow determined from Q vs t curve]		
H3	I5	1-5	Code for the first controlled node	JGW(1)	none
	I5	6-10	Code for the second controlled node	JGW(2)	none
	. . .	. . .			
			Code for the last controlled node	JGW(NJGW)	none

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Table 2. (continued)

Card Group	Format	Columns	Description	Variable Name	Default Value
			[There will be NTRIB H4 data cards]		
H4	2I5	1-5	Channel number of the Ith tributary channel	ITRIB(I,1)	none
		6-10	Junction number of the first upstream node in the small tributary	ITRIB(I,2)	none
			[Repeat this card for each junction]		
			[Junction cards (maximum = 500)]		
H5	I5	1-5	Junction number	J	none
	F10.0	6-15	Water surface-elevation (m)	HEAD(J)	none
	F10.0	16-25	Surface area of junction (km^2)	AS(J)=SURF	none
	F10.0	26-35	Constant flow input to the junction (m^3/sec)	QIN(J)=QF1	none
	F10.0	36-45	Constant flow out of the junction (m^3/sec)	QOU(J)=QF2	none
	F10.0	46-55	Junction bottom elevation in m	DEP(J)=DT	none
	5X	56-60	Leave columns blank		
H6	I5	1-5	To terminate junction cards, write 99999.		none

Table 2. (continued)

Card Group	Format	Columns	Description	Variable Name	Default Value
H7			[Repeat this card group for each channel being simulated. (maximum = 600)]		
	5I5	1-5	Channel number	N	none
		6-10	Junction at one end of channel	NTEMP(1)	none
		11-15	Junction at other end of channel	NTEMP(2)	none
	5F10.0	26-35	Length of channel (m)	ALEN	none
		36-45	Width of channel (m)	WIDTH	none
		46-55	Average elevation of channel bottom (m)	RAD	none
		56-65	Manning's coefficient for the channel	COEF	0.018
		66-75	Initial velocity (m/sec)	VEL	0.0
H8	I5	1-5	To terminate channel cards, write 99999.		none

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Table 2. (continued)

Card Group	Format	Columns	Description	Variable Name	Default Value
			[Card group H9 is used to specify the time varying and/or constant data for the controlled nodes. The type of controlled node was specified on card group H3 above. There must be one set of H9 cards for each controlled node. The first set inputs the information for the first controlled node, the second set for the second controlled node, etc. The format of the H9 cards depends upon which type of controlled node has been specified. The formats are as follows:]		
			[WEIR TYPE (code = 1)]		
H9a	20A4	1-80	Title card		
H9b	3F10.0	1-10	Weir coefficient	A0(1,J,1)	none
		11-20	Weir crest elevation, m	A0(1,J,2)	none
		21-30	Weir exponent	A0(1,J,3)	none
			[TIDALLY INFLUENCED NODE (code = 2)]		
H9a	20A4	1-80	Title card		
H9b	NAMELIST option				
		2-6	Place $CARD1 in columns 2-6.		
		7-72	KØ = (0 or 1, If 0 is used input is ignored. If 1 is used a full tidal cycle will be generated from only four points entered below), NI = (number of tidal stage data points), MAXIT = (Maximum number of iterations for curve fit, usually 50), TT = (list time points in hours separated by commas at which tidal heights will be specified), YY = (values of the tidal		

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Table 2. (continued)

Card Group	Format	Columns	Description	Variable Name	Default Value
			stage in meters separated by commas, which correspond to the time vaulues, TT, listed above.) The $CARD1 can consist of more than one card but all data and separating commas must be listed in any column between 2-72 on each card.		
H9c		2-6	Place $END in columns 2-5 to indicate the end of the data.		
			The formats for the remaining four types of controlled nodes are the same. The rest of the controlled node types and the flow hydrograph inputs specify inputs which can be time varying functions. The following NAMELIST option is used for these inputs. For each variable the input format is one set of cards as follows: Title card $CARD1 $END Columns 20-80 of the title card is used as a free field to identify the data. If the word CONST is placed in columns 2-6 of the title card then the $CARD1 and $END cards will not be used. Instead the number listed in columns 7-18 of the title card will be used as a constant value for the variable. If the input is to specify a time varying function (i.e. CONST does not appear in columns 2-6 of the title card) the $CARD1 must be present and have the following form:		

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Table 2. (continued)

Card Group	Format	Columns	Description	Variable Name	Default Value
		Column 2-6	$CARD1		
		Column 7-72	M = (number [integer] of data points used; maximum value = 20), MIN = (number [integer] giving minimum order of polynomial to be used to fit data), MAX = (number [integer] giving maximum order of polynominal to be used to fit data), X = (a list of time values separated by commas), Y = (a list of the values, separated by commas, of the function corresponding to the time values specified by X above)		
		The $CARD1 can consist of more than one card but all data (including the separating commas) must be listed between columns 2-72 on each card.			
			[Q vs H Dam (code = 3)]		
H9a-c	NAMELIST Option		Values of flows and heads (the head corresponds to X = in the discussion above and the flow to Y =)		
			[H vs t and Q vs t Dam (code = 4)]		
H9a-c	NAMELIST Option		Values of head and times		
H9b-c	NAMELIST Option		Values of flow and times		
			[H vs t Dam (code = 5)]		
H9a-c	NAMELIST Option		Values of head and times		
			[Q vs t Dam (code = 6)]		
H9a-c	NAMELIST Option		Values of flow and times		

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Table 2. (continued)

Data Group	Format	Columns	Description	Variable Name	Default Value
			[Hydrograph input cards. One set of H10 cards must be present for each input node, specified on card H2 above. The first set of hydrograph input cards is for the first input node above, the second for the second node, etc. The MAMELIST option is used on these cards and is discussed above.]		
H10		–	The values of flow (Y =) must be followed by the following variable: HYDEND = (time in seconds that designates end of hydrograph input)		
H10a	20AX	1-80	TITLE CARD		
H10b	NAMELIST Option				
		2-6 7-72	Place $CARD1 in column 2-6 M = (number Integer of data point used), MIN = (number Integer giving minimum order of polynomial to be used to fit data. This number is disregarded by the program), MAX = (number Integer giving maximum order of polynomial to be used to fit data. This number is disregarded by the program) X = (a list of time values in hours, separated by commas), Y = (a list of flow rates in m^3/sec, separated by commas)		
H11	Must contain all asterisks and is the terminator card for the hydrodynamic input deck.				

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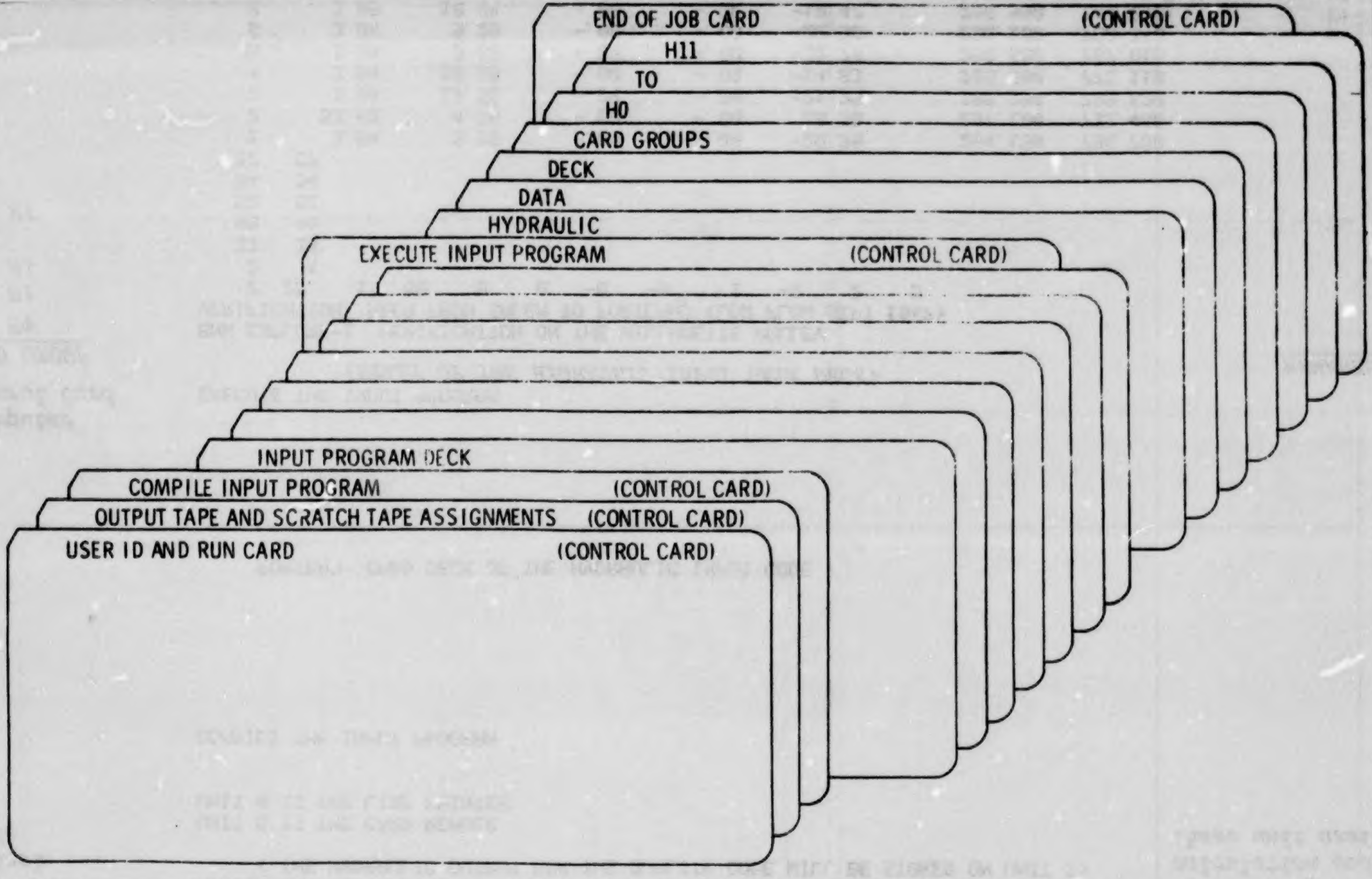
END OF JOB CARD
(CONTROL CARD)
H11
TO
H0
CARD GROUPS
DECK
DATA
HYDRAULIC
EXECUTE INPUT PROGRAM
(CONTROL CARD)
INPUT PROGRAM DECK
COMPILE INPUT PROGRAM
(CONTROL CARD)
OUTPUT TAPE AND SCRATCH TAPE ASSIGNMENTS
(CONTROL CARD)
USER ID AND RUN CARD
(CONTROL CARD)

Figure 6. Sample data deck construction for executing the BNW EXPLORE-I hydraulic input code.

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Table 3 and Figure 7 provide input specifications for the additional cards required for running and receiving output from the calculation code. No output is printed or plotted while the hydraulic code is running. As the program is run, a scratch file of the time history of the flows, velocities, heads, inflow, outflow, and volumes for all the junctions and channels is written to tape. These values are output once, as average values, for each quality time step. This scratch file begins with tidal day NQSWRT and is written through tidal day NTCYC. Since a hydraulic model of a river basin can produce voluminous output, the code has been set up to allow selection of junctions and channels in user-grouped and labeled sets of 20 or less for print and/or lineprinter plot output. Any particular or continuous set of 7 or less simulated tidal days starting with tidal day NQSWRT can be specified. Limiting the output to groups of 20 or fewer junctions and channels will prevent production of unwanted volumes of printout. However, since at times the user may want printout for more than 20 junctions and channels, as many groups of 20 or less as are needed may be requested. An advantage of this method is that the output can be ordered into reaches or tributaries.

Data card group P1 allows the user to request the punching of a restart hydraulic deck. The restart deck includes the H group of data cards, with revised values for the initial water surface elevations of the junctions and for the initial channel velocities.

Figures 8 and 9 provide an example application of the hydraulic component of EXPLORE-I to Four Mile and Wolf Creeks in Iowa. For this case, EXPLORE-I was run by a UNIVAC 1100 computer. Figure 8 is a stick diagram of the physical layout of the system. Figure 9 is an annotated listing of the input data used in this application and described in Tables 2 and 3. As can be seen from Figures 8 and 9, junction 1 and associated channel 1 are the downstream controls, with the control being a dam with a constant head of 1.0 m (option 5). Junctions 2 and 26 have constant inflows; a hydrograph input exists at junction 14. The simulation runs for 2 days (NTCYC = 2). Printed output will be obtainable for each hour of the two days output values and plots for all 57 junctions and channels. The accuracy of the input data for the initial channel velocities indicates that the listed input is the result of a restart deck.

PROGRAMMING INFORMATION

This section describes the two separate executable programs - the input code and the calculation code - which constitute the hydraulic module of EXPLORE-I. Figure 10 shows the relationship of these programs, which must be executed in sequence. A listing of the two codes may be found in Appendix A. The variables used in the hydraulic program and their definitions are

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Table 3. Control Cards for Requesting Punch, Print and Plot Output From Hydraulic Calculation Code

Card Group	Format	Columns	Description	Variable Name	Default Value
P1	I5	1-5	Switch to request the punching of a restart deck. Any number other than 0 causes a restart deck to be punched.	IDECK	none
			Card groups P2 - P8 are repeated for each group of 20 or less junctions and channels to be printed and/or plotted.		
P2	20A4	1-80	Descriptive title for the group of junction and channel data to be printed and/or plotted	RUNTIT(I) I=1, 20	none
P3	2I10	1-10	The number of tidal day where printing and/or plotting will commence (NQSWRT ≤ IDAY1 ≤ IDAYL)	IDAY1	none
		11-20	The number of the last tidal day to be printed and/or plotted (note IDAYL - IDAY1 is limited to be ≤ 7) (NQSWRT ≤ IDAYL ≤ NTCYC)	IDAYL	none
P4	I10	1-10	The number of junctions for which print and/or plot information is requested (≤20)	NJP	none
P5	20I5	1-4 5-8 9-12 . . . 76-80	Array of NJP junction numbers for which printout is desired (the junction printout will be in the order dictated by this array)	NJW(1) NJW(2) NJW(3) . . . NJW(20)	none

Table 3. (continued)

Card Group	Format	Columns	Description	Variable Name	Default Value
P6	I10	1-10	The number of channels for which print and/or plot information is requested (≤ 20)	NCP	none
P7	20I4	1-4	Array of NCP channel numbers for which print and/or plot information is desired (The channel printout will be in the order dictated by this array.)	NCW(1)	none
		5-8		NCW(2)	
		9-12		NCW(3)	
		.		.	
		.		.	
		.		.	
		77-80		NCW(20)	
P8	I5	1-5	Switch to request plots for the channel flows and junction heads (NPLOTS = 0, then suppress the plots)	NPLOTS	none

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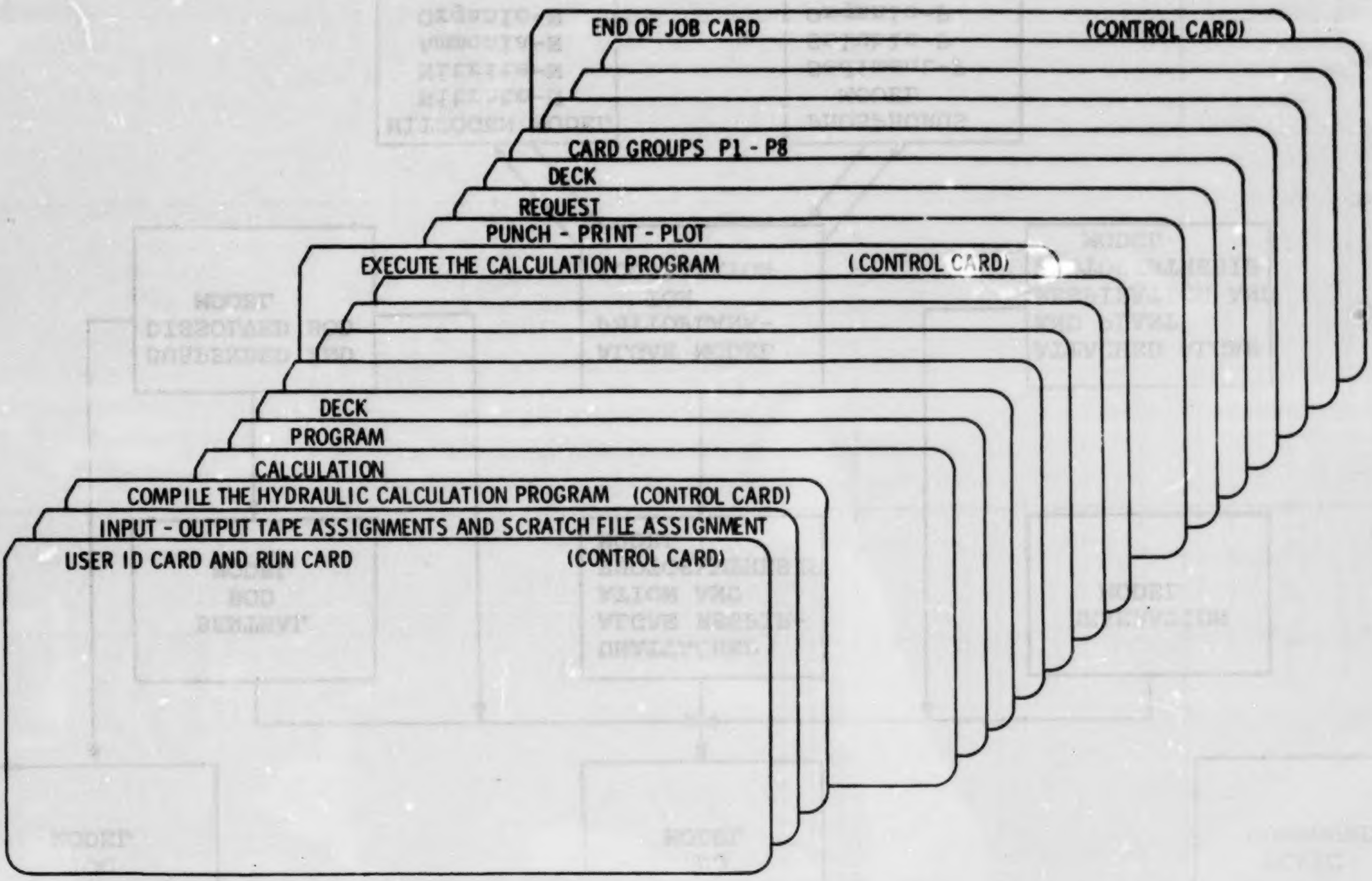
END OF JOB CARD
(CONTROL CARD)
CARD GROUPS P1 - P8
DECK
REQUEST
PUNCH - PRINT - PLOT
EXECUTE THE CALCULATION PROGRAM
(CONTROL CARD)
DECK
PROGRAM
CALCULATION
COMPILE THE HYDRAULIC CALCULATION PROGRAM
(CONTROL CARD)
INPUT - OUTPUT TAPE ASSIGNMENTS AND SCRATCH FILE ASSIGNMENT
USER ID CARD AND RUN CARD
(CONTROL CARD)

Figure 7. Sample data deck construction for executing the BNW EXPLORE-I hydraulic calculation code.

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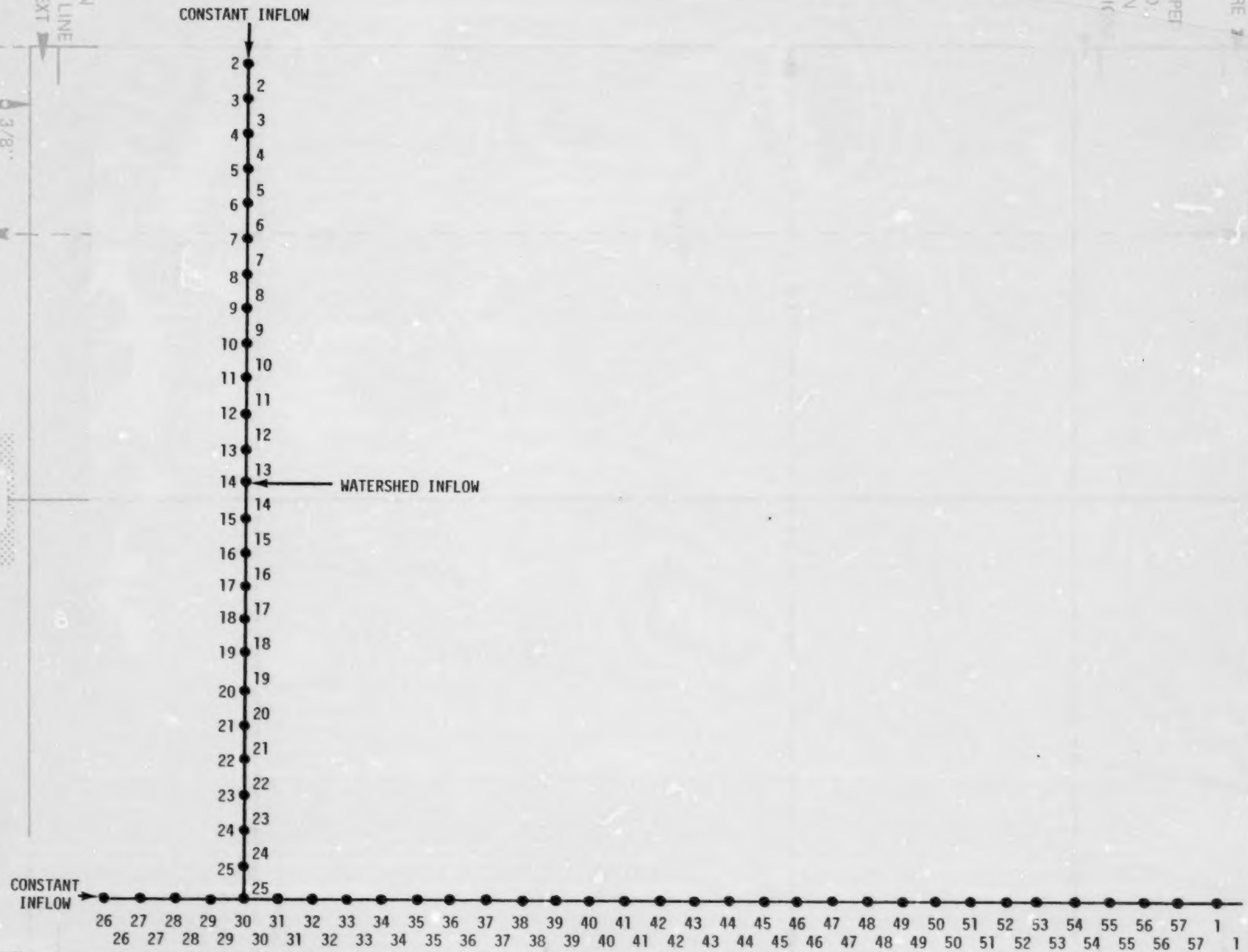
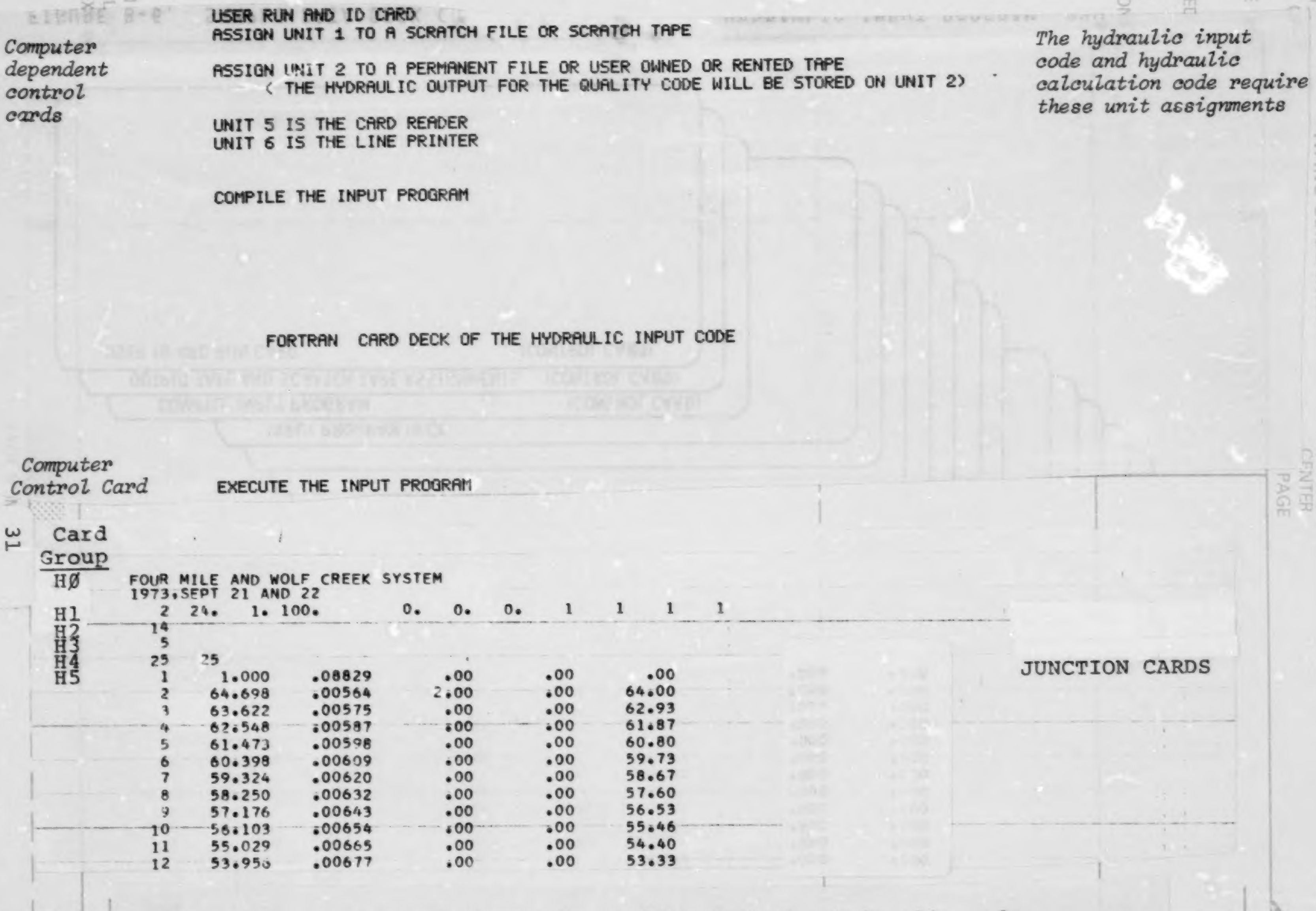

CONSTANT INFLOW
WATERSHED INFLOW
CONSTANT INFLOW

Figure 8. Layout of example system.



Computer dependent control cards

```
USER RUN AND ID CARD
ASSIGN UNIT 1 TO A SCRATCH FILE OR SCRATCH TAPE

ASSIGN UNIT 2 TO A PERMANENT FILE OR USER OWNED OR RENTED TAPE
     ( THE HYDRAULIC OUTPUT FOR THE QUALITY CODE WILL BE STORED ON UNIT 2)

UNIT 5 IS THE CARD READER
UNIT 6 IS THE LINE PRINTER


COMPILE THE INPUT PROGRAM
```

The hydraulic input code and hydraulic calculation code require these unit assignments

```
FORTRAN  CARD DECK OF THE HYDRAULIC INPUT CODE
```

Computer Control Card

```
EXECUTE THE INPUT PROGRAM
```

Card
Group

```
HØ    FOUR MILE AND WOLF CREEK SYSTEM
      1973,SEPT 21 AND 22
H1       2  24.    1. 100.        0.    0.    0.    1    1    1    1
H2      14
H3       5
H4      25   25
H5       1    1.000     .08829       .00        .00        .00
         2   64.698     .00564      2.00        .00      64.00
         3   63.622     .00575       .00        .00      62.93
         4   62.548     .00587       .00        .00      61.87
         5   61.473     .00598       .00        .00      60.80
         6   60.398     .00609       .00        .00      59.73
         7   59.324     .00620       .00        .00      58.67
         8   58.250     .00632       .00        .00      57.60
         9   57.176     .00643       .00        .00      56.53
        10   56.103     .00654       .00        .00      55.46
        11   55.029     .00665       .00        .00      54.40
        12   53.956     .00677       .00        .00      53.33
```

Figure 9. Listing of sample input data deck for hydraulic code.

```
            13    52.882    .00688      .00       .00      52.26
            14    51.811    .00699      .00       .00      51.20
            15    50.736    .00710      .00       .00      50.13
            16    49.668    .00721      .00       .00      49.06
            17    48.586    .00733      .00       .00      48.00
            18    47.532    .00744      .00       .00      46.93
            19    46.424    .00755      .00       .00      45.86
            20    45.421    .00766      .00       .00      44.79
            21    44.219    .00778      .00       .00      43.73
            22    43.417    .00789      .00       .00      42.66
            23    43.343    .00800      .00       .00      41.59
            24    43.333    .00811      .00       .00      40.53
            25    39.752    .00823      .00       .00      39.46
            26    44.519    .04415     5.00       .00      43.88
            27    43.108    .04415      .00       .00      42.51
            28    41.807    .04415      .00       .00      41.13
            29    40.317    .04415      .00       .00      39.76
            30    39.156    .04829      .00       .00      38.39
            31    37.764    .04636      .00       .00      37.02
            32    36.373    .04856      .00       .00      35.65
            33    34.983    .05077      .00       .00      34.28
            34    33.595    .05298      .00       .00      32.91
            35    32.206    .05519      .00       .00      31.54
            36    30.820    .05739      .00       .00      30.17
            37    29.435    .05960      .00       .00      28.80
            38    28.051    .06181      .00       .00      27.42
            39    26.666    .06401      .00       .00      26.05
            40    25.282    .06622      .00       .00      24.68
            41    23.898    .06843      .00       .00      23.31
            42    22.519    .07064      .00       .00      21.94
            43    21.137    .07284      .00       .00      20.57
            44    19.757    .07505      .00       .00      19.20
            45    18.376    .07726      .00       .00      17.82
            46    16.999    .07947      .00       .00      16.45
            47    15.618    .08168      .00       .00      15.08
            48    14.245    .08388      .00       .00      13.71
            49    12.860    .08609      .00       .00      12.34
            50    11.497    .08829      .00       .00      10.97
            51    10.114    .08829      .00       .00       9.60
            52     8.778    .08829      .00       .00       8.23
            53     7.367    .08829      .00       .00       6.86
            54     6.081    .08829      .00       .00       5.48
            55     4.591    .08829      .00       .00       4.11
            56     3.435    .08829      .00       .00       2.74
            57     1.733    .08829      .00       .00       1.37
H6     99999
H7          1     0     1          2414.0000   36.5760     .0000    .0400    .0000
            2     2     3           804.7000    7.0800   63.4680    .0700    .4085
            3     3     4           804.7000    7.2200   62.4010    .0700    .4053
```

CHANNEL CARDS

Figure 9. (continued)

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```
   4   4   5      804.7000    7.3590   61.3340   .0700   .4022
   5   5   6      804.7000    7.4990   60.2670   .0700   .3992
   6   6   7      804.7000    7.6390   59.2000   .0700   .3962
   7   7   8      804.7000    7.7790   58.1330   .0700   .3933
   8   8   9      804.7000    7.9190   57.0660   .0700   .3905
   9   9  10      804.7000    8.0590   55.9990   .0700   .3877
  10  10  11      804.7000    8.1980   54.9320   .0700   .3851
  11  11  12      804.7000    8.3380   53.8650   .0700   .3824
  12  12  13      804.7000    8.4770   52.7980   .0700   .3800
  13  13  14      804.7000    8.6170   51.7310   .0700   .3773
  14  14  15      804.7000    8.7560   50.6640   .0700   .3753
  15  15  16      804.7000    8.8960   49.5970   .0700   .3721
  16  16  17      804.7000    9.0350   48.5300   .0700   .3712
  17  17  18      804.7000    9.1750   47.4630   .0700   .3662
  18  18  19      804.7000    9.3150   46.3960   .0700   .3693
  19  19  20      804.7000    9.4550   45.3290   .0700   .3566
  20  20  21      804.7000    9.5950   44.2620   .0700   .3738
  21  21  22      804.7000    9.7350   43.1950   .0700   .3300
  22  22  23      804.7000    9.8740   42.1280   .0700   .1619
  23  23  24      804.7000   10.0140   41.0610   .0700   .0878
  24  24  25      804.7000   10.1540   39.9940   .0700   .1275
  25  25  30      804.7000   10.2940   38.9270   .0700   .2512
  26  26  27     2414.0000   18.2880   43.1920   .0400   .4401
  27  27  23     2414.0000   18.2880   41.8210   .0400   .4299
  28  28  29     2414.0000   18.2880   40.4500   .0400   .4471
  29  29  30     2414.0000   18.2880   39.0790   .0400   .4159
  30  30  31     2414.0000   18.7460   37.7080   .0400   .4970
  31  31  32     2414.0000   19.6600   36.3370   .0400   .4872
  32  32  33     2414.0000   20.5750   34.9660   .0400   .4784
  33  33  34     2414.0000   21.4890   33.5950   .0400   .4699
  34  34  35     2414.0000   22.4040   32.2240   .0400   .4623
  35  35  36     2414.0000   23.3180   30.8520   .0400   .4547
  36  36  37     2414.0000   24.2330   29.4810   .0400   .4478
  37  37  38     2414.0000   25.1470   28.1100   .0400   .4411
  38  38  39     2414.0000   26.0610   26.7390   .0400   .4350
  39  39  40     2414.0000   26.9750   25.3670   .0400   .4291
  40  40  41     2414.0000   27.8900   23.9950   .0400   .4236
  41  41  42     2414.0000   28.8040   22.6240   .0400   .4179
  42  42  43     2414.0000   29.7190   21.2540   .0400   .4133
  43  43  44     2414.0000   30.6330   19.8820   .0400   .4084
  44  44  45     2414.0000   31.5480   18.5110   .0400   .4041
  45  45  46     2414.0000   32.4620   17.1400   .0400   .3998
  46  46  47     2414.0000   33.3770   15.7690   .0400   .3964
  47  47  48     2414.0000   34.2910   14.3980   .0400   .3922
  48  48  49     2414.0000   35.2050   13.0270   .0400   .3901
  49  49  50     2414.0000   36.1190   11.6550   .0400   .3859
  50  50  51     2414.0000   36.5760   10.2840   .0400   .3876
  51  51  52     2414.0000   36.5760    8.9130   .0400   .3868
  52  52  53     2414.0000   36.5760    7.5420   .0400   .3961
  53  53  54     2414.0000   36.5760    6.1710   .0400   .3893
  54  54  55     2414.0000   36.5760    4.8000   .0400   .4095
  55  55  56     2414.0000   36.5760    3.4280   .0400   .3837
  56  56  57     2414.0000   36.5760    2.0570   .0400   .4315
  57   1  57     2414.0000   36.5760     .6860   .0400  -.3396
H8  99999
```

Figure 9. (continued)

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Constant head controlled node
Hydrograph input

```
H9a    CONST        1.0
H10a   WATERSHED INFLOW
   b   $CARD1 M=19,MIN=6,MAX=6
       X=0.,1.,2.,3.,4.,5.,6.,7.,8.,9.,10.,11.,12.,13.,14.,15.,16.,17.,18.,
       Y=.436,3.26,11.941,17.228,20.786,16.011,1.306,1.084,1.013,.948,.886,
         .829,.776,.725,.678,.634,.593,.554,0.,HYDEND=68400.
   c   $END
H11    ************************************************************************
```

Computer Control Card COMPILE THE CALCULATION PROGRAM

FORTRAN CARD DECK OF THE HYDRAULIC CALCULATION CODE

Computer Control Card EXECUTE THE CALCULATION PROGRAM

```
P1         0
P2     FOUR MILE CREEK AND WOLF CREEK
P3           1         7
P4           20
P5       1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20
P6           20
P7       1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20
P8       1
       FOUR MILE CREEK AND WOLF CREEK
             1         7
             20
        21  22  23  24  25  26  27  28  29  30  31  32  33  34  35  36  37  38  39  40
             20
        21  22  23  24  25  26  27  28  29  30  31  32  33  34  35  36  37  38  39  40
         1
       FOUR MILE CREEK AND WOLF CREEK
             1         7
             17
        41  42  43  44  45  46  47  48  49  50  51  52  53  54  55  56  57
             17
        41  42  43  44  45  46  47  48  49  50  51  52  53  54  55  56  57
         1
```

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COMPUTER CONTROL CARD END OF RUN

Figure 9. (continued)

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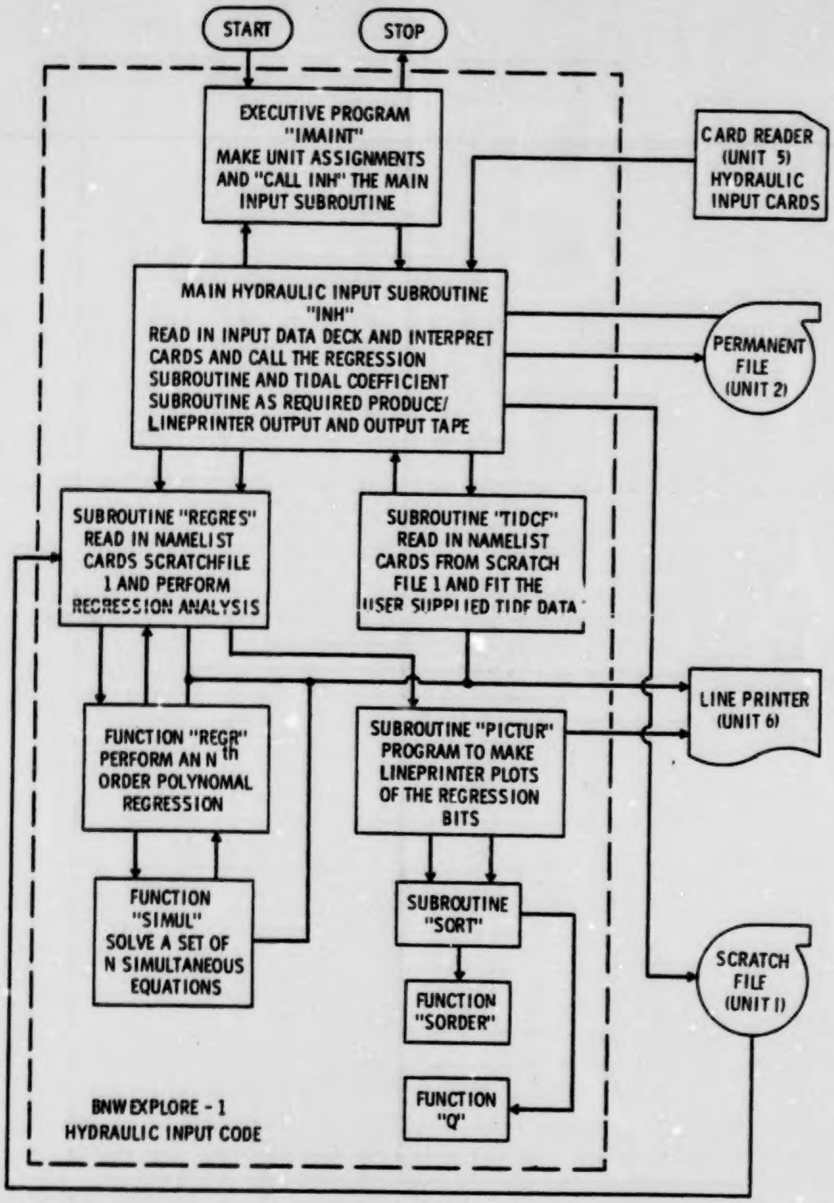
START
STOP
EXECUTIVE PROGRAM "IMAINT" MAKE UNIT ASSIGNMENTS AND "CALL INH" THE MAIN INPUT SUBROUTINE
CARD READER (UNIT 5) HYDRAULIC INPUT CARDS
MAIN HYDRAULIC INPUT SUBROUTINE "INH" READ IN INPUT DATA DECK AND INTERPRET CARDS AND CALL THE REGRESSION SUBROUTINE AND TIDAL COEFFICIENT SUBROUTINE AS REQUIRED PRODUCE/ LINEPRINTER OUTPUT AND OUTPUT TAPE
PERMANENT FILE (UNIT 2)
SUBROUTINE "REGRES" READ IN NAMELIST CARDS SCRATCHFILE 1 AND PERFORM REGRESSION ANALYSIS
SUBROUTINE "TIDCF" READ IN NAMELIST CARDS FROM SCRATCH FILE 1 AND FIT THE USER SUPPLIED TIDE DATA
LINE PRINTER (UNIT 6)
FUNCTION "REGR" PERFORM AN Nth ORDER POLYNOMAL REGRESSION
SUBROUTINE "PICTUR" PROGRAM TO MAKE LINEPRINTER PLOTS OF THE REGRESSION BITS
FUNCTION "SIMUL" SOLVE A SET OF N SIMULTANEOUS EQUATIONS
SUBROUTINE "SORT"
FUNCTION "SORDER"
SCRATCH FILE (UNIT 1)
FUNCTION "Q"
BNW EXPLORE - 1 HYDRAULIC INPUT CODE

Figure 10. Relationship of the hydraulic input, calculation and output codes.

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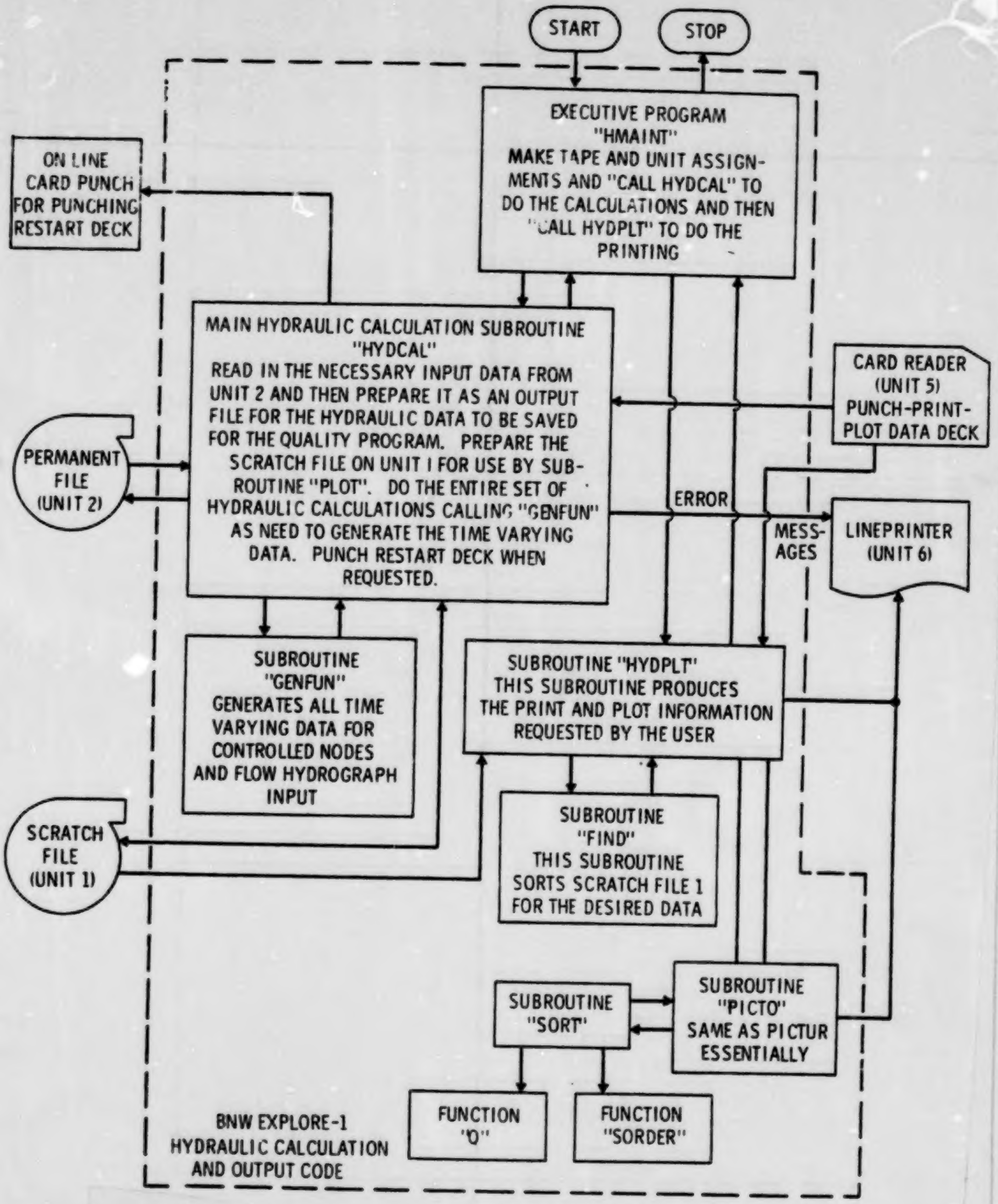
START
STOP
EXECUTIVE PROGRAM "HMAINT" MAKE TAPE AND UNIT ASSIGNMENTS AND "CALL HYDCAL" TO DO THE CALCULATIONS AND THEN "CALL HYDPLT" TO DO THE PRINTING
ON LINE CARD PUNCH FOR PUNCHING RESTART DECK
MAIN HYDRAULIC CALCULATION SUBROUTINE "HYDCAL" READ IN THE NECESSARY INPUT DATA FROM UNIT 2 AND THEN PREPARE IT AS AN OUTPUT FILE FOR THE HYDRAULIC DATA TO BE SAVED FOR THE QUALITY PROGRAM. PREPARE THE SCRATCH FILE ON UNIT I FOR USE BY SUBROUTINE "PLOT". DO THE ENTIRE SET OF HYDRAULIC CALCULATIONS CALLING "GENFUN" AS NEED TO GENERATE THE TIME VARYING DATA. PUNCH RESTART DECK WHEN REQUESTED.
CARD READER (UNIT 5) PUNCH-PRINT-PLOT DATA DECK
PERMANENT FILE (UNIT 2)
ERROR
MESSAGES
LINEPRINTER (UNIT 6)
SUBROUTINE "GENFUN" GENERATES ALL TIME VARYING DATA FOR CONTROLLED NODES AND FLOW HYDROGRAPH INPUT
SUBROUTINE "HYDPLT" THIS SUBROUTINE PRODUCES THE PRINT AND PLOT INFORMATION REQUESTED BY THE USER
SCRATCH FILE (UNIT 1)
SUBROUTINE "FIND" THIS SUBROUTINE SORTS SCRATCH FILE 1 FOR THE DESIRED DATA
SUBROUTINE "SORT"
SUBROUTINE "PICTO" SAME AS PICTUR ESSENTIALLY
FUNCTION "Q"
FUNCTION "SORDER"
BNW EXPLORE-1 HYDRAULIC CALCULATION AND OUTPUT CODE

Figure 10. (continued).

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listing of the two codes may be found in Appendix A. The variables used in the hydraulic program and their definitions are given in Table 4.

Hydraulic Input Program (IMAINT) Description

The executive program is MAIN (formerly IMAINT). This program serves only to make I/O device assignments and to call the main input subroutine INH. Subroutine INH reads in the input data necessary for the hydraulic calculations. INH calls subroutine TIDE (formerly TIDCF) when a fit of the stage versus time data is required and subroutine REGRES when it is necessary to fit time varying data on controlled nodes or flow hydrographs. Figure 11 shows a flow chart for subroutine INH.

Subroutine REGRES is a standard polynomial regression program taken from Reference 6. This program reads in an array of M ordered data points and does a user-specified set of Nth order polynomial regressions ($1 \leq N \leq 9$). In each case print and plot data indicating the quality of the fit are produced. REGRES calls on functions REGR and SIMUL for the regressions and on subroutine PICTUR for the line-printer plots. Details of this subroutine can be found in Reference 6.

Subroutine TIDE calculates the coefficients of the tidal function H(t) = A1 + A2*SIN(t) + A3*SIN(2t) + A4*SIN(3t) + A5*COS(t) + A6*COS(2t) + A7*COS(3t) from input values of H and T by a least squares procedure. Figure 12 is a flow chart of TIDE.

Subroutine PICTUR prepares a lineprinter plot of a set of N data points. Figure 13 shows a flow chart of PICTUR. This subroutine uses subroutine SORT and functions SORDER and Q to sort the plot points according to descending values of Y.

Hydraulic Calculations Program (HMAINT) Description

Executive Program MAIN (formerly HMAINT) serves only to make I/O device assignments and to call the calculation subroutine HYDCAL and the print-plot program HYDPLT.

Subroutine HYDCAL, the hydraulic calculation program, receives its input data from tape unit 2 and carries out the hydraulic computations. HYDCAL calls subroutine GENFUN as required to generate all time varying input functions and to solve the weir formula. Figure 14 shows a flow diagram of HYDCAL.

Subroutine GENFUN, a flow diagram of which is shown in Figure 15, is used to solve the weir formula and to generate the functional values of all input variables which were fit via polynomial regression.

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Table 4. Variable Definition for Hydraulic Code

Variable Name	Location	Description
A(500)	C	Channel cross-section area at start of time-step (HYDCAL,INH)
AK(600)	C	Modified friction factor (HYDCAL,INH)
ALPHA(30)	C	Title for printing (HYDCAL,INH)
ALEN		Channel length (INH)
ARRAY(33)		Dummy array used in printing (HYDCAL,INH)
AREA		Computed nodal area to find initial nodal volume (HYDCAL)
AS(500)	C	Node surface area (HYDCAL,INH)
AT(600)	C	Channel cross-section at midpoint of time-step (HYDCAL,INH)
A(3,20,10)	C	Array used to store the regression coefficients and wier constants (HYDCAL,INH)
ATEMP(10)		Variable to pass the regression constants (INH)
ASTERK		Variable containing asterisk (HYDCAL,INH)
ATOT		Total surface area of receiving water (INH)
ASTER		Variable containing asterisk
A1 A2 A3 A4 A5 A6 A7		Coefficients of the expression $H(WT) \doteq A + A2*COS(WT) + A3*COS(2WT) + A4*COS(3WT) + A5*SIN(WT) + A6*SIN(2WT) + A7*SIN(3WT) + A8*SIN(4WT)$ for tidal input

Table 4. (continued)

Variable Name	Location	Description
B(600)	C	Channel width (HYDCAL,INH)
BLANK		Variable containing blank (INH)
COEF		Manning's coefficient for channel (INH)
DEL		Temporary variable
DELH DELHH		Increment of head of a junction for a time-step (HYDCAL)
DELMAX		Maximum difference between the calculated and stage input
DELTA		Maximum allowable difference between the calculated and input tidal stage
DELT	C	Time-step increment (HYDCAL,INH)
DELTH		Temporary variable (HYDCAL)
DELTQ	C	Length of quality time-step (usually an hour); (HYDCAL,INH)
DELT2		1/2 time-step increment (HYDCAL)
DELV1 DELV2		Component of velocity change during a time-step (HYDCAL)
DEP(500)	C	Depth of water of a junction at zero datum (HYDCAL,INH)
DEPTH		Computed depth of node at a junction for initial volume (HYDCAL)
DIFF		Difference between the calculated and input tidal stage
DT		Junction depth (INH)
DVOL		Volume change in a time-step (HYDCAL)
EVAP	C	Evaporation rate for whole system converted from ft/mo (HYDCAL,INH)
EWIND(600)	C	Drag force due to wind (HYDCAL,INH)

Table 4. (continued)

Variable Name	Location	Description
FJ1		Internal variable
FJ3		Internal variable
H(500)	C	Head at junction at beginning of time-step (HYDCAL,INH)
HAVE(500)	C	Junction average head during a daily cycle (HYDCAL)
HBAR(500)	C	Junction average head during a quality cycle (HYDCAL)
HEAD		Distance water surface is from datum plane (INH)
HN(500)	C	Junction head at end of time-step (HYDCAL)
HOUR		Time-hours
HYDRAD(600)	C	Hydraulic radius (INH)
HT(500)	C	Junction head at end of 1/2 time-step (HYDCAL)
IDELT		Length of hydraulic cycle (integration step) (INH)
IDECK		Switch variable to request restart deck be punched (HYDCAL)
I II IHJN IL IJK IJN		Index numbers (HYDCAL,INH)
IFLAG		Variable to indicate small tributary channel (INH)
IPERID		Length of tidal cycle (INH)
IPOINT(500,6)	C	Pointer array containing node to node connections (HYDCAL,INH)
IQINT		Length of quality cycle (INH)
IT		Iteration counter

Table 4. (continued)

Variable Name	Location	Description
ITRIB(50,2)	C	Array containing the channel numbers of the small tributary channels and also the associated junction numbers (HYDCAL,INH)
J		Index variable (HYDCAL,INH)
JGW(20)	C	Array indicating the type of controlled node I is (HYDCAL,INH)
JSW(20)	C	Array of junction numbers which have time varying flow input (HYDCAL,INH)
K		Index variable (HYDCAL,INH)
KO		Switch to cause generation of a full tide from HHW, LLW, HLW, LHW
LEN(600)	C	Channel length (HYDCAL,INH)
M		Index variable (HYDCAL,INH)
MAXIT		Maximum number of iterations in tidal curve fit, usually 50
N		Index variable (HYDCAL,INH)
NC	C	Number of channels (HYDCAL,INH)
NCHAN(500,6)	C	Channels associated with nodes (HYDCAL,INH)
NCLOS(600)	C	If equal to 1 channel dry, otherwise no effect (INH,HYDCAL)
NDRY		Number of dry junctions (HYDCAL)
NEXIT	C	Set equal to 1 when error condition exists (HYDCAL,INH)
NH		Node at channel end (HYDCAL)
NHH		Hydraulic cycle counter (HYDCAL)
NHCYC	C	Number of time-steps per quality cycle (HYDCAL,INH)
NI		Number of tidal input values
NINT		Number of hydraulic cycles per tidal cycle (INH)

Table 4. (continued)

Variable Name	Location	Description
NJGW	C	Number of controlled nodes (HYDCAL,INH)
NJ	C	Number of junctions (HYDCAL,INH)
NJ2		Temporary variables
NJGW1		NJGW+1 (HYDCAL)
NJSW	C	Number of junctions with time varying flow hydrograph input (HYDCAL,INH)
NJUNC(600,2)	C	Nodes at channel ends (HYDCAL,INH)
NL		Node at channel end (HYDCAL)
NQ		Quality cycle counter (HYDCAL)
NQCYC	C	Number of quality cycles per day (HYDCAL,INH)
NQSWRT	C	Number of daily cycles at which printing will start (HYDCAL,INH)
NT	C	Daily cycle number (HYDCAL,INH)
NTCYC	C	Number of daily cycles to be simulated (HYDCAL,INH)
NTEMP(6)	C	Temporary array of channels entering a node (HYDCAL,INH)
NTIMS		Number of times through drying up connection (HYDCAL)
NTRIB	C	Number of small tributary channels (HYDCAL,INH)
NTT		Temporary variables
NX		Temporary variable (HYDCAL)
N5	C	Card reader of equivalent (HYDCAL,INH)
N6	C	Lineprinter (HYDCAL,INH)
N7	C	(Fake printer) scratch file or permanent file (INH)
N20	C	Hydraulic input and output file (HYDCAL,INH)

Table 4. (continued)

Variable Name	Location	Description
N22	C	Scratch file (equal to N20 in HYDCAL)
N24	C	Scratch file
PERIOD	C	Period in hours of daily cycle (HYDCAL,INH,TIDCF)
Q(600)	C	Channel flow (HYDCAL,INH)
QAVE(600)	C	Daily cycle average flow (HYDCAL)
QBAR(600)	C	Quality cycle average flow (HYDCAL)
QF1		Temporary storage for junction inflow (INH)
QF2		Temporary storage for junction outflow (INH)
QIN(500)	C	Inflows to junctions (HYDCAL,INH)
QUINBAR(500)	C	Quality cycle average junction inflow (HYDCAL)
QINST(20)	C	Array for storing the constant inflow at junctions with flow hydrograph input (HYDCAL)
QUINT	C	Quality time-step interval (HYDCAL,INH)
QJ2		Temporary variable (HYDCAL)
QOU(500)	C	Outflow from junction (HYDCAL,INH)
QOUBAR(500)	C	Quality cycle average junction outflow (HYDCAL,INH)
R1(600)	C	Hydraulic radius (HYDCAL,INH)
RAD		Channel depth measured from datum (HYDCAL,INH)
RES		Accumulative difference between the calculated and input tidal stage
RNT		Temporary hydraulic radius at 1/2 time-step (HYDCAL)
SURF		Temporary storage for junction surface area (HYDCAL)

Table 4. (continued)

Variable Name	Location	Description
SUM		Computed tidal stage
SUMQ		Total flow leaving junction (HYDCAL)
SXX(10,10)		Matrix used for least square tidal fit
SXY(10)		Vector used for least square tidal fit
TITLE(33)		Title arrary read from cards
T		Time counter for whole analysis (HYDCAL)
TT(50)		Time from start of storm of input for tidal condition and from hydrograph file
T2		T + 1/2 Δt (HYDCAL)
TEMP		Simplifying variable used during solution of velocities (HYDCAL)
TF		Estimate maximum time-step for channel (INH)
TIME		Time counter for time varying input
TIM2		Time + 1/2 Δt
TRBDEP(50)	C	Small tributary channels mid-point depth measured from datum (HYDCAL,INH)
VEL		Temporary storage of velocity (INH)
V(600)	C	Channel velocity at start of time-step (HYDCAL,INH)
VBAR(600)	C	Average velocity during quality cycle (HYDCAL)
VOL(500)	C	Nodal volume (HYDCAL,INH)
VOLUME		Initial nodal volume (HYDCAL)

Table 4. (continued)

Variable Name	Location	Description
VT(600)	C	Channel velocity at 1/2 time-step (HYDCAL)
V2		Velocity during a half hydraulic time-step (HYDCAL)
W	C	Fundamental frequency of daily tidal variation (HYDCAL,INH)
WDIR	C	Wind direction in degrees from north (HYDCAL,INH)
WIDTH		Width of channel (INH)
WIND	C	Wind force (HYDCAL,INH)
X(J)	C	X coordinate of junctions (HYDCAL,INH)
X1		Temporary storage x coordinate (INH)
XMK		Blank or asterisk depending on whether estimated maximum time-step is satisfied (INH)
XX(10)		Vector used in least square tidal fit
Y(J)	C	Y coordinate of junctions (HYDCAL,INH)
Y1		Temporary storage for y coordinate (INH)

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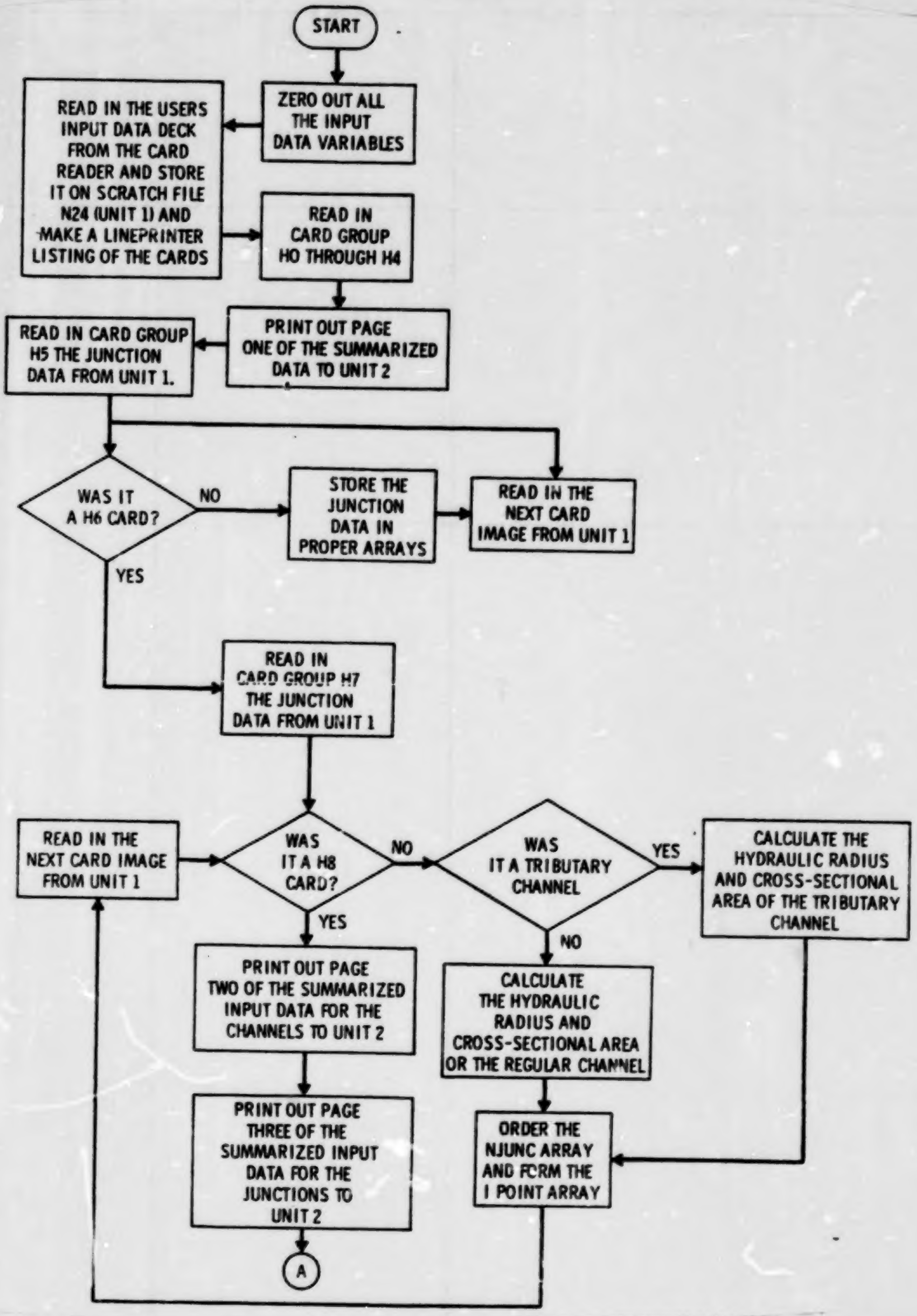
START
ZERO OUT ALL THE INPUT DATA VARIABLES
READ IN THE USERS INPUT DATA DECK FROM THE CARD READER AND STORE IT ON SCRATCH FILE N24 (UNIT 1) AND MAKE A LINEPRINTER LISTING OF THE CARDS
READ IN CARD GROUP HO THROUGH H4
PRINT OUT PAGE ONE OF THE SUMMARIZED DATA TO UNIT 2
READ IN CARD GROUP H5 THE JUNCTION DATA FROM UNIT 1.
WAS IT A H6 CARD?
NO
STORE THE JUNCTION DATA IN PROPER ARRAYS
READ IN THE NEXT CARD IMAGE FROM UNIT 1
YES
READ IN CARD GROUP H7 THE JUNCTION DATA FROM UNIT 1
READ IN THE NEXT CARD IMAGE FROM UNIT 1
WAS IT A H8 CARD?
NO
WAS IT A TRIBUTARY CHANNEL
YES
CALCULATE THE HYDRAULIC RADIUS AND CROSS-SECTIONAL AREA OF THE TRIBUTARY CHANNEL
YES
PRINT OUT PAGE TWO OF THE SUMMARIZED INPUT DATA FOR THE CHANNELS TO UNIT 2
NO
CALCULATE THE HYDRAULIC RADIUS AND CROSS-SECTIONAL AREA OR THE REGULAR CHANNEL
PRINT OUT PAGE THREE OF THE SUMMARIZED INPUT DATA FOR THE JUNCTIONS TO UNIT 2
ORDER THE NJUNC ARRAY AND FORM THE I POINT ARRAY
A

Figure 11. Flow chart of subroutine INH.

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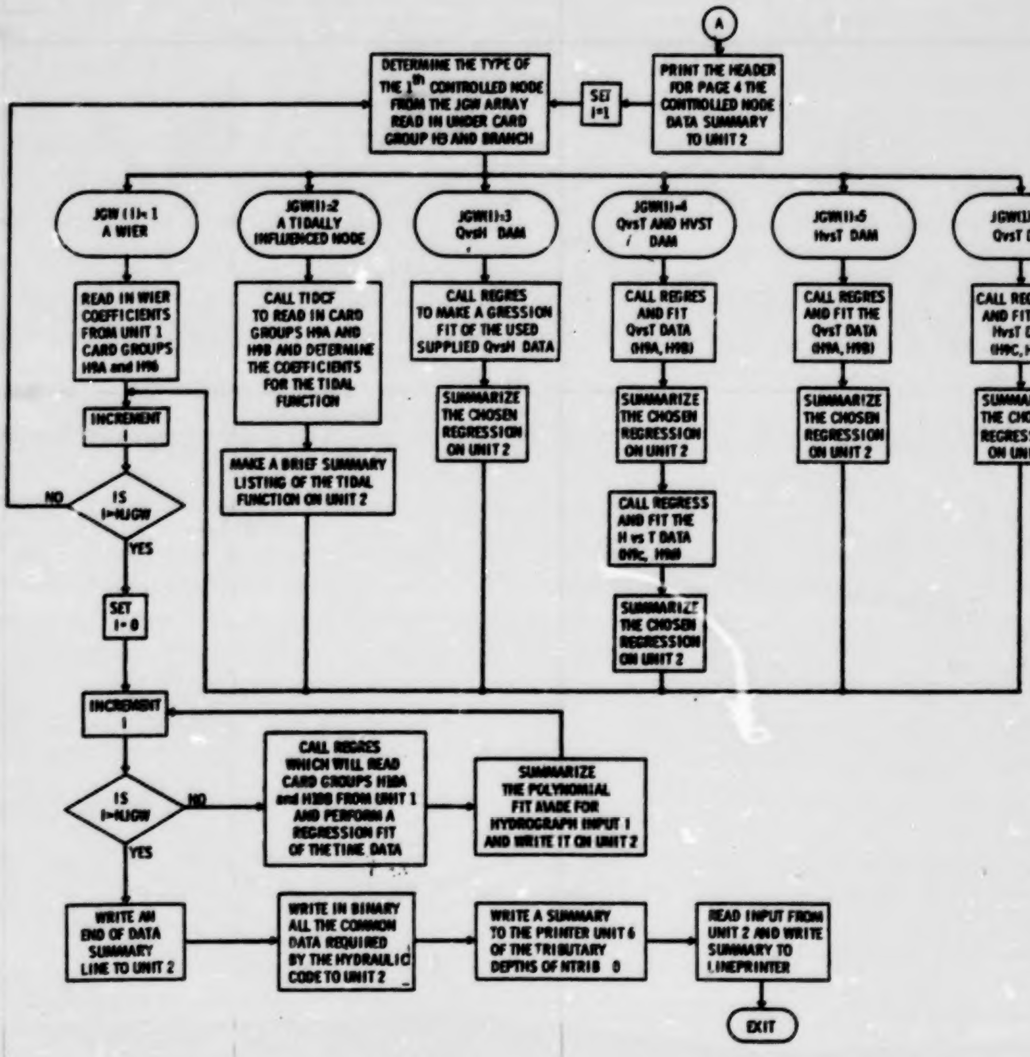
A
DETERMINE THE TYPE OF THE Ith CONTROLLED NODE FROM THE JGW ARRAY READ IN UNDER CARD GROUP H3 AND BRANCH
SET I=1
PRINT THE HEADER FOR PAGE 4 THE CONTROLLED NODE DATA SUMMARY TO UNIT 2
JGW (I)= 1 A WIER
JGW(I)=2 A TIDALLY INFLUENCED NODE
JGW(I)=3 QvsH DAM
JGW(I)=4 QvsT AND HVST / DAM
JGW(I)=5 HvsT DAM
JGW(I) = 6 QvsT DAM
READ IN WIER COEFFICIENTS FROM UNIT 1 CARD GROUPS H9A and H96
CALL TIDCF TO READ IN CARD GROUPS H9A AND H9B AND DETERMINE THE COEFFICIENTS FOR THE TIDAL FUNCTION
CALL REGRES TO MAKE A GRESSION FIT OF THE USED SUPPLIED QvsH DATA
CALL REGRES AND FIT QvsT DATA (H9A, H9B)
CALL REGRES AND FIT THE QvsT DATA (H9A, H9B)
CALL REGRESS AND FIT THE HvsT DATA (H9C, H9D)
INCREMENT I
MAKE A BRIEF SUMMARY LISTING OF THE TIDAL FUNCTION ON UNIT 2
SUMMARIZE THE CHOSEN REGRESSION ON UNIT 2
SUMMARIZE THE CHOSEN REGRESSION ON UNIT 2
SUMMARIZE THE CHOSEN REGRESSION ON UNIT 2
SUMMARIZE THE CHOSEN REGRESSION ON UNIT 2
NO
IS I=NJGW
YES
CALL REGRESS AND FIT THE H vs T DATA (H9c, H9D)
SUMMARIZE THE CHOSEN REGRESSION ON UNIT 2
SET I=0
INCREMENT I
IS I=NJGW
NO
YES
CALL REGRES WHICH WILL READ CARD GROUPS H10A and H10B FROM UNIT 1 AND PERFORM A REGRESSION FIT OF THE TIME DATA
SUMMARIZE THE POLYNOMIAL FIT MADE FOR HYDROGRAPH INPUT I AND WRITE IT ON UNIT 2
WRITE AN END OF DATA SUMMARY LINE TO UNIT 2
WRITE IN BINARY ALL THE COMMON DATA REQUIRED BY THE HYDRAULIC CODE TO UNIT 2
WRITE A SUMMARY TO THE PRINTER UNIT 6 OF THE TRIBUTARY DEPTHS OF NTRIB 0
READ INPUT FROM UNIT 2 AND WRITE SUMMARY TO LINEPRINTER
EXIT

Figure 11. (continued).

BEGIN LAST LINE OF TEXT
BOTTOM OF IMAGE AREA, OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
3/8"

PAGE NUMBER
EPA-287 (Cin.)
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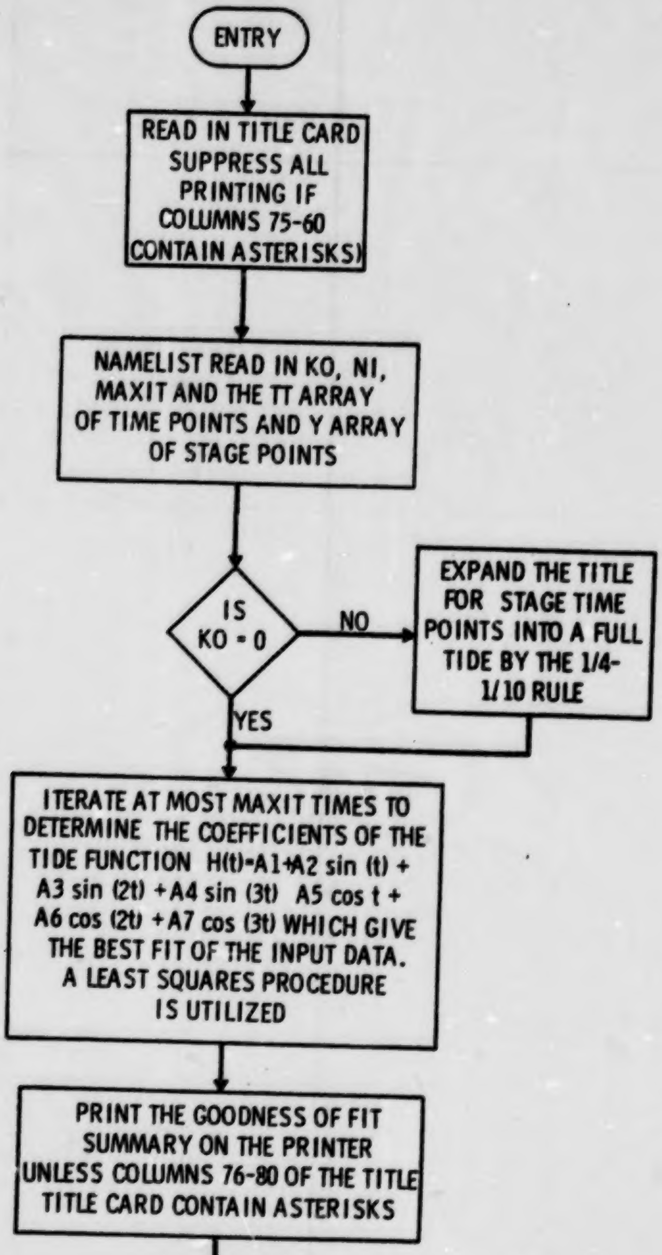
ENTRY
READ IN TITLE CARD SUPPRESS ALL PRINTING IF COLUMNS 75-60 CONTAIN ASTERISKS)
NAMELIST READ IN KO, NI, MAXIT AND THE TT ARRAY OF TIME POINTS AND Y ARRAY OF STAGE POINTS
IS KO = 0
NO
EXPAND THE TITLE FOR STAGE TIME POINTS INTO A FULL TIDE BY THE 1/4-1/10 RULE
YES
ITERATE AT MOST MAXIT TIMES TO DETERMINE THE COEFFICIENTS OF THE TIDE FUNCTION H(t)=A1+A2 sin (t) + A3 sin (2t) + A4 sin (3t) A5 cos t + A6 cos (2t) + A7 cos (3t) WHICH GIVE THE BEST FIT OF THE INPUT DATA. A LEAST SQUARES PROCEDURE IS UTILIZED
PRINT THE GOODNESS OF FIT SUMMARY ON THE PRINTER UNLESS COLUMNS 76-80 OF THE TITLE TITLE CARD CONTAIN ASTERISKS
EXIT

Figure 12. Flow chart of TIDE.

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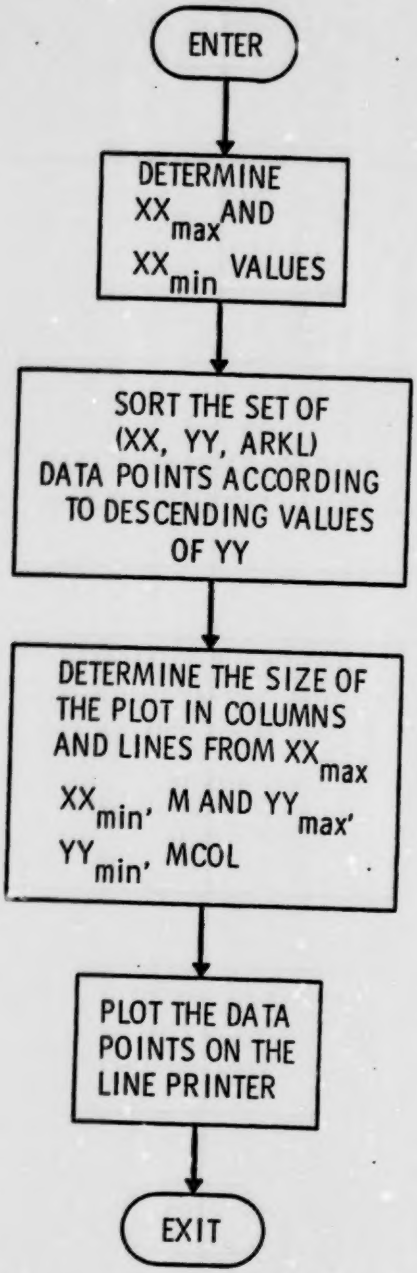
ENTER
DETERMINE XX$_{max}$ AND XX$_{min}$ VALUES
SORT THE SET OF (XX, YY, ARKL) DATA POINTS ACCORDING TO DESCENDING VALUES OF YY
DETERMINE THE SIZE OF THE PLOT IN COLUMNS AND LINES FROM XX$_{max}$ XX$_{min}$, M AND YY$_{max}$, YY$_{min}$, MCOL
PLOT THE DATA POINTS ON THE LINE PRINTER
EXIT

Figure 13. Flow chart of subroutine PICTUR.

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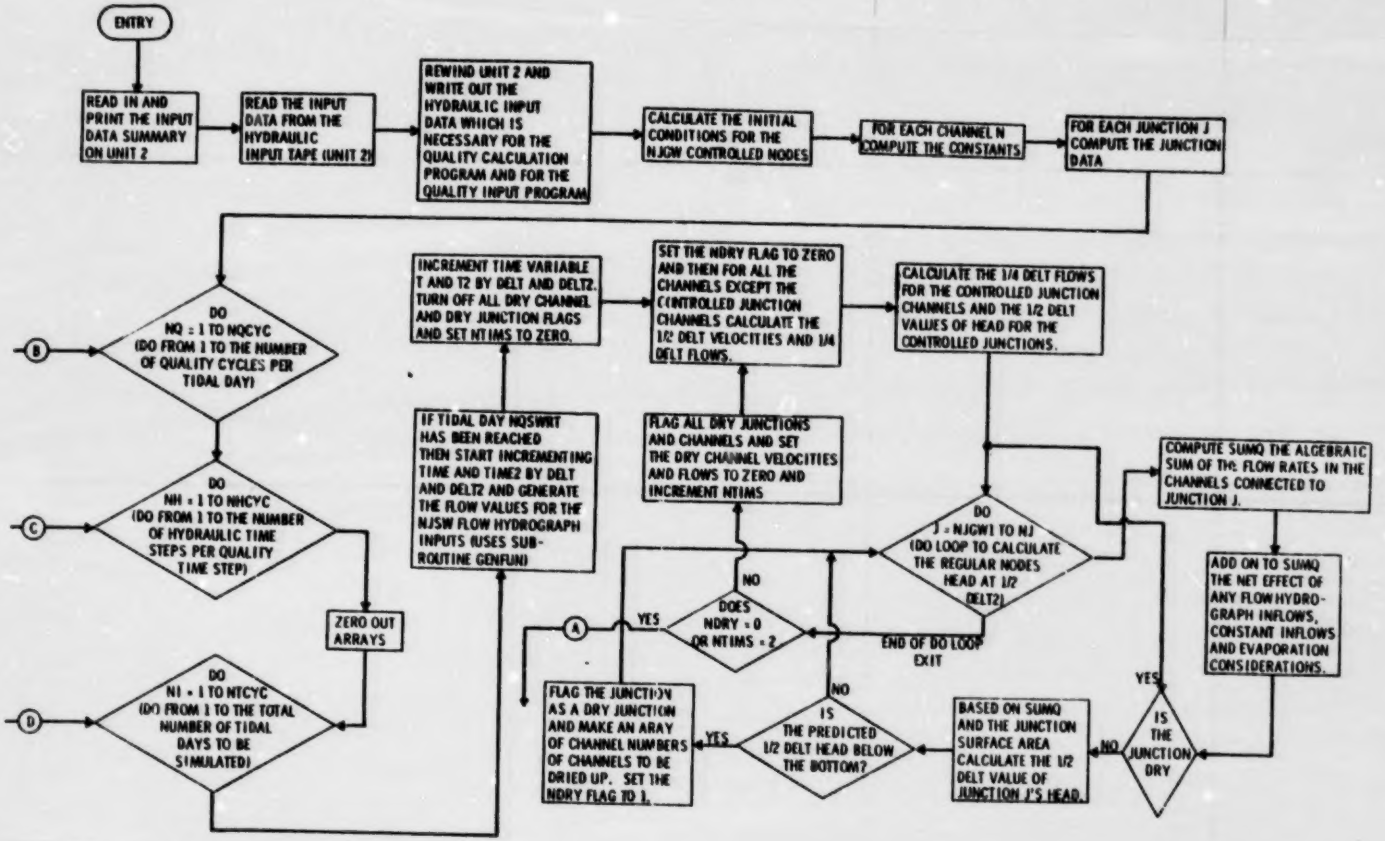
ENTRY
READ IN AND PRINT THE INPUT DATA SUMMARY ON UNIT 2
READ THE INPUT DATA FROM THE HYDRAULIC INPUT TAPE (UNIT 2)
REWIND UNIT 2 AND WRITE OUT THE HYDRAULIC INPUT DATA WHICH IS NECESSARY FOR THE QUALITY CALCULATION PROGRAM AND FOR THE QUALITY INPUT PROGRAM
CALCULATE THE INITIAL CONDITIONS FOR THE NJGW CONTROLLED NODES
FOR EACH CHANNEL N COMPUTE THE CONSTANTS
FOR EACH JUNCTION J COMPUTE THE JUNCTION DATA
B
DO NQ = 1 TO NQCYC (DO FROM 1 TO THE NUMBER OF QUALITY CYCLES PER TIDAL DAY)
C
DO NH = 1 TO NHCYC (DO FROM 1 TO THE NUMBER OF HYDRAULIC TIME STEPS PER QUALITY TIME STEP)
ZERO OUT ARRAYS
D
DO NI = 1 TO NTCYC (DO FROM 1 TO THE TOTAL NUMBER OF TIDAL DAYS TO BE SIMULATED)
IF TIDAL DAY NQSWRT HAS BEEN REACHED THEN START INCREMENTING TIME AND TIME2 BY DELT AND DELT2 AND GENERATE THE FLOW VALUES FOR THE NJSW FLOW HYDROGRAPH INPUTS (USES SUB-ROUTINE GENFUN)
INCREMENT TIME VARIABLE T AND T2 BY DELT AND DELT2. TURN OFF ALL DRY CHANNEL AND DRY JUNCTION FLAGS AND SET NTIMS TO ZERO.
SET THE NDRY FLAG TO ZERO AND THEN FOR ALL THE CHANNELS EXCEPT THE CONTROLLED JUNCTION CHANNELS CALCULATE THE 1/2 DELT VELOCITIES AND 1/4 DELT FLOWS.
CALCULATE THE 1/4 DELT FLOWS FOR THE CONTROLLED JUNCTION CHANNELS AND THE 1/2 DELT VALUES OF HEAD FOR THE CONTROLLED JUNCTIONS.
FLAG ALL DRY JUNCTIONS AND CHANNELS AND SET THE DRY CHANNEL VELOCITIES AND FLOWS TO ZERO AND INCREMENT NTIMS
DO J = NJGW1 TO NJ (DO LOOP TO CALCULATE THE REGULAR NODES HEAD AT 1/2 DELT2)
COMPUTE SUMQ THE ALGEBRAIC SUM OF THE FLOW RATES IN THE CHANNELS CONNECTED TO JUNCTION J.
ADD ON TO SUMQ THE NET EFFECT OF ANY FLOW HYDRO-GRAPH INFLOWS, CONSTANT INFLOWS AND EVAPORATION CONSIDERATIONS.
NO
DOES NDRY = 0 OR NTIMS = 2
YES
A
END OF DO LOOP EXIT
YES
IS THE JUNCTION DRY
NO
BASED ON SUMQ AND THE JUNCTION SURFACE AREA CALCULATE THE 1/2 DELT VALUE OF JUNCTION J'S HEAD.
NO
IS THE PREDICTED 1/2 DELT HEAD BELOW THE BOTTOM?
YES
FLAG THE JUNCTION AS A DRY JUNCTION AND MAKE AN ARAY OF CHANNEL NUMBERS OF CHANNELS TO BE DRIED UP. SET THE NDRY FLAG TO 1.

Figure 14. Flow chart of subroutine HYDCAL.

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BOTTOM OF IMAGE AREA: OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
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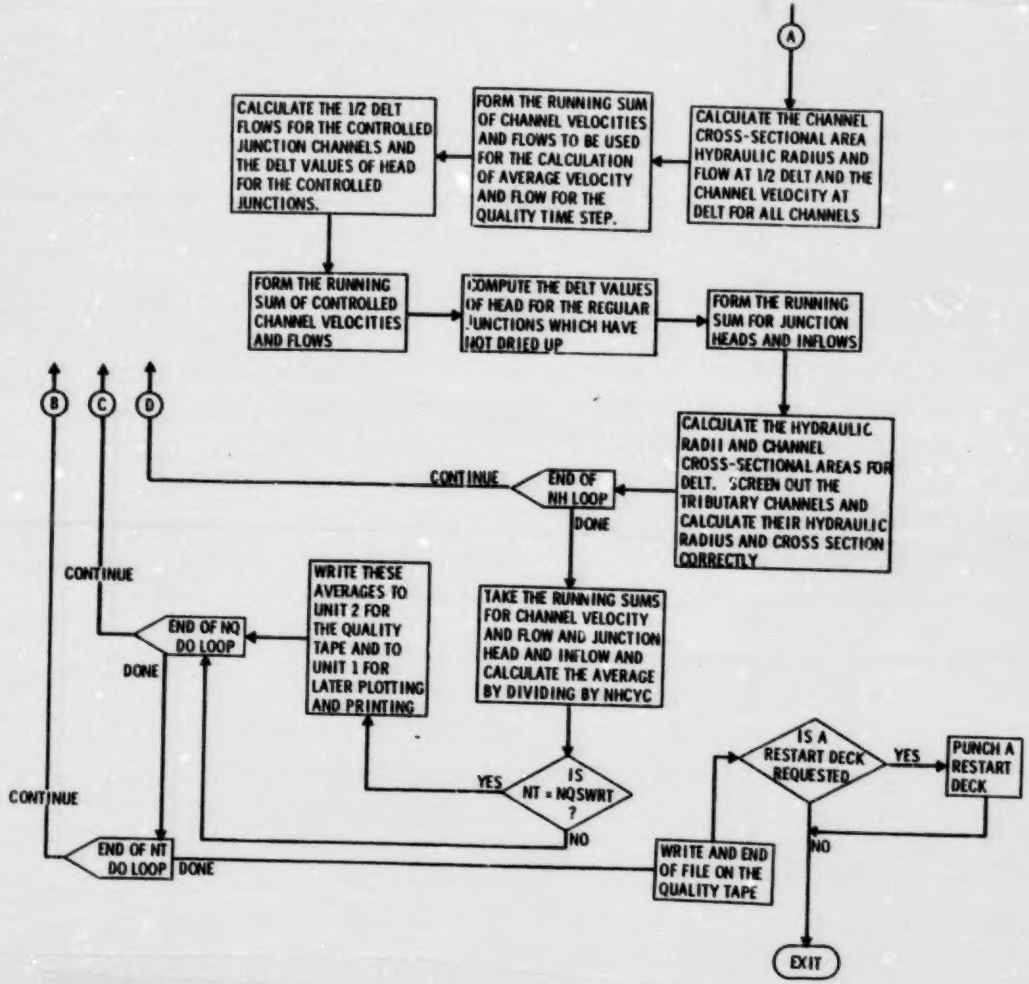
A
CALCULATE THE CHANNEL CROSS-SECTIONAL AREA HYDRAULIC RADIUS AND FLOW AT 1/2 DELT AND THE CHANNEL VELOCITY AT DELT FOR ALL CHANNELS
FORM THE RUNNING SUM OF CHANNEL VELOCITIES AND FLOWS TO BE USED FOR THE CALCULATION OF AVERAGE VELOCITY AND FLOW FOR THE QUALITY TIME STEP.
CALCULATE THE 1/2 DELT FLOWS FOR THE CONTROLLED JUNCTION CHANNELS AND THE DELT VALUES OF HEAD FOR THE CONTROLLED JUNCTIONS.
FORM THE RUNNING SUM OF CONTROLLED CHANNEL VELOCITIES AND FLOWS
COMPUTE THE DELT VALUES OF HEAD FOR THE REGULAR JUNCTIONS WHICH HAVE NOT DRIED UP
FORM THE RUNNING SUM FOR JUNCTION HEADS AND INFLOWS
CALCULATE THE HYDRAULIC RADII AND CHANNEL CROSS-SECTIONAL AREAS FOR DELT. SCREEN OUT THE TRIBUTARY CHANNELS AND CALCULATE THEIR HYDRAULIC RADIUS AND CROSS SECTION CORRECTLY
END OF NH LOOP
CONTINUE
DONE
D
TAKE THE RUNNING SUMS FOR CHANNEL VELOCITY AND FLOW AND JUNCTION HEAD AND INFLOW AND CALCULATE THE AVERAGE BY DIVIDING BY NHCYC
IS NT = NQSWRT ?
YES
NO
WRITE THESE AVERAGES TO UNIT 2 FOR THE QUALITY TAPE AND TO UNIT 1 FOR LATER PLOTTING AND PRINTING
END OF NQ DO LOOP
CONTINUE
DONE
C
END OF NT DO LOOP
CONTINUE
DONE
B
WRITE AND END OF FILE ON THE QUALITY TAPE
IS A RESTART DECK REQUESTED
YES
NO
PUNCH A RESTART DECK
EXIT

Figure 14. (continued).

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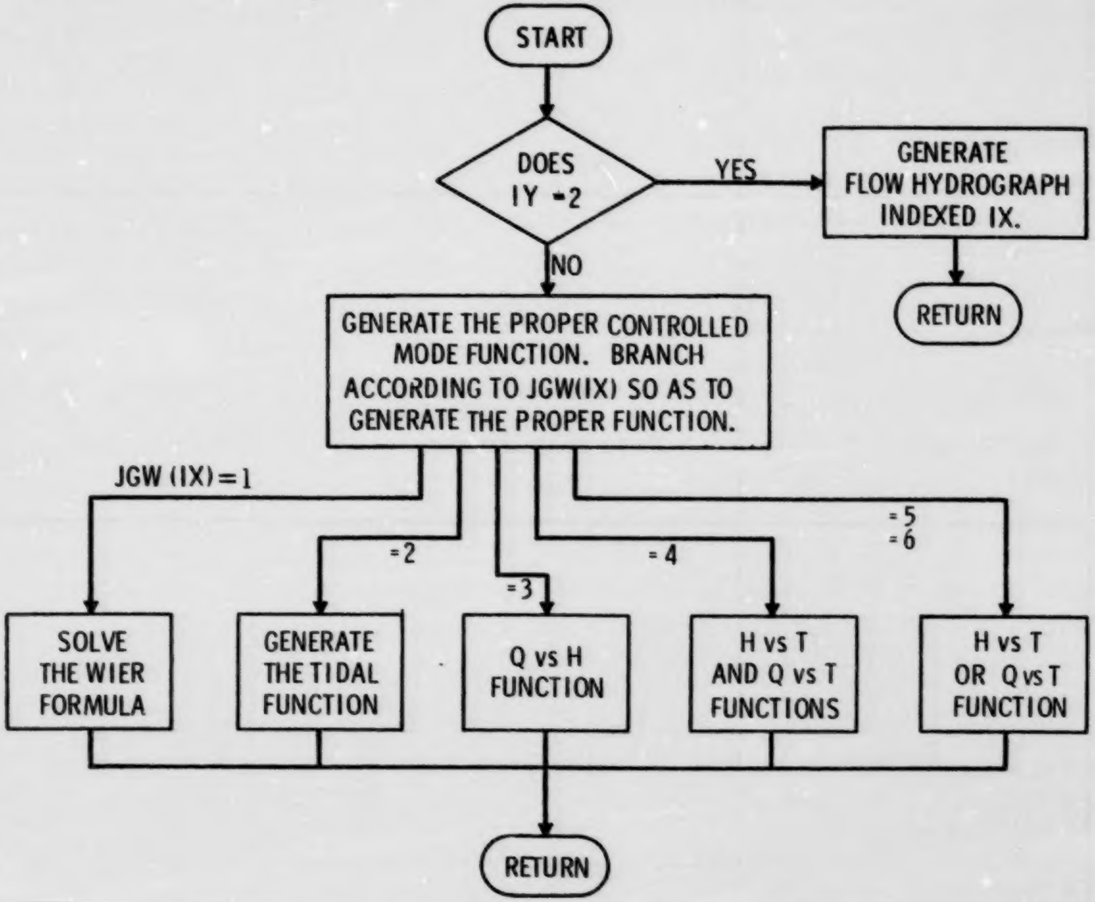
START
DOES IY =2
YES
GENERATE FLOW HYDROGRAPH INDEXED IX.
RETURN
NO
GENERATE THE PROPER CONTROLLED MODE FUNCTION. BRANCH ACCORDING TO JGW(IX) SO AS TO GENERATE THE PROPER FUNCTION.
JGW (IX) = 1
=2
=3
=4
=5
=6
SOLVE THE WIER FORMULA
GENERATE THE TIDAL FUNCTION
Q vs H FUNCTION
H vs T AND Q vs T FUNCTIONS
H vs T OR Q vs T FUNCTION
RETURN

Figure 15. Flow diagram of subroutine GENFUN.

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Subroutine HYDPLT is used to print out the hydraulic information calculated by HYDCAL for the user-requested sets of junctions and channels. Figure 16 is a flow diagram of subroutine HYDPLT. The plotting program PICTO used by HYDPLT is identical to PICTUR, except that titles are printed on the plots and a check insures that the data plotted covers 75% or more of the X axis.

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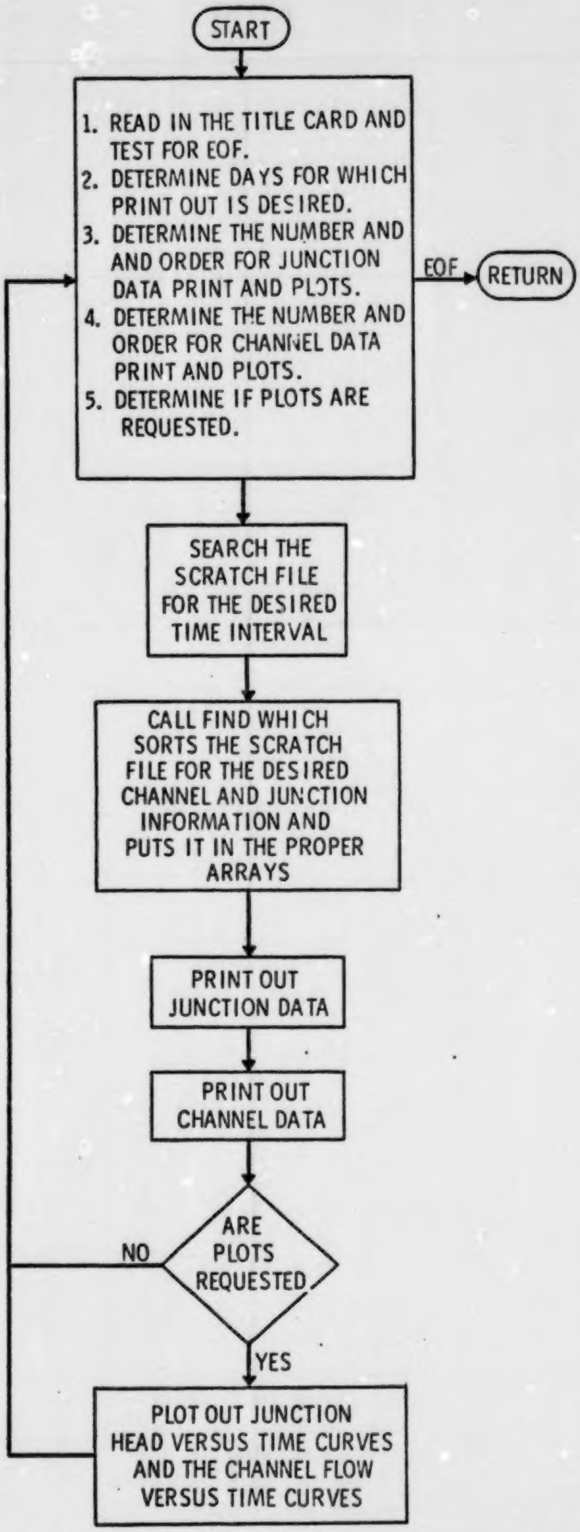
START
1. READ IN THE TITLE CARD AND TEST FOR EOF.
2. DETERMINE DAYS FOR WHICH PRINT OUT IS DESIRED.
3. DETERMINE THE NUMBER AND AND ORDER FOR JUNCTION DATA PRINT AND PLOTS.
4. DETERMINE THE NUMBER AND ORDER FOR CHANNEL DATA PRINT AND PLOTS.
5. DETERMINE IF PLOTS ARE REQUESTED.
EOF
RETURN
SEARCH THE SCRATCH FILE FOR THE DESIRED TIME INTERVAL
CALL FIND WHICH SORTS THE SCRATCH FILE FOR THE DESIRED CHANNEL AND JUNCTION INFORMATION AND PUTS IT IN THE PROPER ARRAYS
PRINT OUT JUNCTION DATA
PRINT OUT CHANNEL DATA
ARE PLOTS REQUESTED
NO
YES
PLOT OUT JUNCTION HEAD VERSUS TIME CURVES AND THE CHANNEL FLOW VERSUS TIME CURVES

Figure 16. Flow diagram of subroutine HYDPLT

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REFERENCES

1. Baca, R. G., W. W. Waddel, C. R. Cole, A. Brandstetter and D. B. Cearlock. EXPLORE-I: A River Basin Water Quality Model. Prepared for the U.S. Environmental Protection Agency by Battelle, Pacific Northwest Laboratories, Richland, WA, 1973a.

2. Baca, R. G., W. W. Waddel, C. R. Cole, A. Brandstetter, and D. B. Cearlock. Appendix B. User's Manual for EXPLORE-I: A River Basin Water Quality Model, Prepared for the Environmental Protection Agency, Battelle, Pacific Northwest Laboratories, Richland, WA, August 1973b.

3. Water Resource Engineers, "A Hydraulic Water Quality Model of Suisan and San Pablo Bays." Report to EPA, March 1966.

4. Metcalf and Eddy, Inc. "Storm Water Management Model." Palo Alto, CA, Prepared as EPA Report No. 11024DOC08/71, August 1971.

5. Callaway, R. J., K. V. Bysam and G. R. Ditsworth. "Mathematical Model of the Columbia River from the Pacific Ocean to Bonneville Dam." Federal Water Pollution Central Administration, Pacific Northwest Laboratory, November 1969.

6. Henderson, F. M. Open Channel Flow, Macmillan Company, 1966.

7. Carnahan, B., H. A. Luther, and J. O. Wilkes. Applied Numerical Methods. John Wiley and Sons Inc., 1969.

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APPENDIX A

LISTING OF THE EXPLORE-I HYDRAULIC CODE

Hydraulic Input Computer Program
IMAINT

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Hydraulic Calculational Computer Program
HMAINT

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GENFUN 93
HYDCAL 96
HYDPLT 112
MAIN 119
PICTO 120
SORDER 124
SORT 125

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****** GAUSS ******

@ELT,L IMAINT.GAUSS


000           SUBROUTINE GAUSS (A,X)
000      C      THIS ROUTINE IS CALLED BY TIDE
000           DIMENSION A(8,9),X(8)
000           N=8
000           M=9
000           L=7
000           DO 12 K=1,L
000           JJ=K
000           BIG=ABS(A(K,K))
000           KP1=K+1
000      C    SEARCH FOR LARGEST PIVOT ELEMENT
000           DO 7 I=KP1,N
000           AB=ABS(A(I,K))
000           IF(BIG-AB) 6,7,7
000         6 BIG=AB
000           JJ=I
000         7 CONTINUE
000      C    DECIDE WHETHER ROW INTERCHANGE IS NECESSARY
000           IF(JJ-K) 8,10,8
000      C    INTERCHANGE ROWS
000         8 DO 9 J=K,M
000           TEMP=A(JJ,J)
000           A(JJ,J)=A(K,J)
000         9 A(K,J)=TEMP
000      C    CALCULATE ELEMENTS OF NEW MATRIX
000        10  DO 11 I=KP1,N
000           QUOT=A(I,K)/A(K,K)
000           DO 11 J=KP1,M
000        11 A(I,J)=A(I,J)-QUOT*A(K,J)
000           DO 12 I=KP1,N
000        12 A(I,K)=0.
000      C    FIRST STEP IN BACK SUBSTITUTION
000           X(N)=A(N,M)/A(N,N)
000           DO 14 NN=1,L
000           SUM=0.
000           I=N-NN
000           IP1=I+1
000           DO 13 J=IP1,N
000        13 SUM=SUM+A(I,J)*X(J)
000        14 X(I)=(A(I,M)-SUM)/A(I,I)
000           CONTINUE
000           RETURN
000           END

END ELT.

@HDG,P ****** INH ******
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****** INH ******

*ELT,L IMAINT.INH

000          SUBROUTINE INH
000   C      ************** INPUT PROGRAM FOR EXPLORE-1          *************
000   C
000   C      ************** BATTELLE NORTHWEST 11/9/71           *************
000   C      **************************************************************
000   C       THIS ROUTINE IS CALLED BY IMAINV (OR IMAINT)
000   C       AND CALLS TIDE AND REGRES
000   C
000   C      ************** ASSIGN THE COMMON  DATA              *************
000          COMMON /TAPES/N5,N6,N20,N22,N24
000          COMMON/PARAMS/IZ5,IZ6,IZ9,IZ12,IZ13
000   C
000   C      ************** CONTROL AND TITLE INFORMATION        *************
000          COMMON /PTINT/ NJ,NC,NJGW,NTCYC,NQSWRT,NQCYC,DELTQ,PERIOD,
000         1ALPHA(30),DEP(70),IPOINT(70,6),AS(70),EVAP
000          COMMON/QUAL/NCHAN(70,6),LEN(100),NJUNC(100,2),JGW(20)
000          COMMON/QIN/QINT,DELT,WIND,WDIR,NJSW,     NHCYC,NT,ICYC,NCYC,W,
000         1NEXIT,JSW(20),        A0(3,20,10)
000   C
000   C      ************** JUNCTION INFORMATION                 *************
000   C
000          COMMON/H50/H(70),VOL(70),X(70),Y(70),
000         1QIN(70),QOU(70),QINST(20)
000   C
000   C      ************** CHANNEL INFORMATION                  *************
000   C
000          COMMON/B72/B(100),R(100),A(100),AK(100),Q(100),V(100),
000         1FWIND(100),NTEMP(6),NCLOS(100)
000          DIMENSION HYDRAD(100),ITRIB(50,2),TRBDEP(50)
000   C   *** HYDEND IS A SPECIAL CASE FOR THE EPA PESTICIDE STUDY ***
000          COMMON /NEW/ IJK,CHK,XM(20),YM(20),HYDEND
000   C
000          REAL LEN
000          DIMENSION ARRAY(33),ATEMP(10)
000          DIMENSION ALENM(100),WIDTHM(100),RADM(100),VELM(100),AM(100),
000         1HYDRAM(100)
000          DIMENSION HEADM(70),SURFM(70),QF1M(70),QF2M(70)
000          DIMENSION ATIDE(8)
000          DATA ASTERK,BLANK/4H****,4H    /
000   C      **************                  END                 *************
000   C      **************************************************************
000   C
000   C      ************** ZERO ALL THE INPUT DATA VARIABLES    *************
000          NTCYC=0
000          PERIOD=0.
000          QINT=0.
000          DELT=0.
000          WIND=0.
000          WDIR=0.
000          NQSWRT=0
000          NJSW=0
000          NJGW=0
000          NQCYC=0
```

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****** INH ******
000054     000          NHCYC=0                                                          49
000055     000          NT=0                                                             50
000056     000          DELTQ=0.                                                         51
000057     000          ICYC=0                                                           52
000058     000          NCYC=0                                                           53
000059     000          NEXIT=0                                                          54
000060     000          NJ=0                                                             55
000061     000          NC=0                                                             56
000062     000          NTRIB=0                                                          57
000063     000          DO 100 I=1,50                                                    58
000064     000          TRBDEP(I)=0.                                                     59
000065     000          ITRIB(I,1)=0                                                     60
000066     000    100   ITRIB(I,2)=0                                                     61
000067     000          DO 120 L=1,IZ12                                                  62
000068     000          DO 110 II=1,10                                                   63
000069     000          A0(1,L,II)=0.                                                    64
000070     000          A0(2,L,II)=0.                                                    65
000071     000    110   A0(3,L,II)=0.                                                    66
000072     000          QINST(L)=0.                                                      67
000073     000    120   JSW(L)=0                                                         68
000074     000          DO 130 I=1,IZ13                                                  69
000075     000    130   JGW(I)=0                                                         70
000076     000          DO 140 I=1,30                                                    71
000077     000    140   ALPHA(I)=BLANK                                                   72
000078     000          DO 160 J=1,IZ5                                                   73
000079     000          H(J)=0.                                                          74
000080     000          AS(J)=0.                                                         75
000081     000          VOL(J)=0.                                                        76
000082     000          X(J)=0.                                                          77
000083     000          Y(J)=0.                                                          78
000084     000          DEP(J)=0.                                                        79
000085     000          QIN(J)=0.                                                        80
000086     000          QOU(J)=0.                                                        81
000087     000          DO 150 K=1,IZ6                                                   82
000088     000          NTEMP(K)=0                                                       83
000089     000          IPOINT(J,K)=0                                                    84
000090     000    150   NCHAN(J,K)=0                                                     85
000091     000    160   CONTINUE                                                         86
000092     000          DO 170 I=1,IZ9                                                   87
000093     000          LEN(I)=0.                                                        88
000094     000          NJUNC(I,1)=0                                                     89
000095     000          NJUNC(I,2)=0                                                     90
000096     000          B(I)=0.                                                          91
000097     000          R(I)=0.                                                          92
000098     000          A(I)=0.                                                          93
000099     000          AK(I)=0.                                                         94
000100     000          Q(I)=0.                                                          95
000101     000          V(I)=0.                                                          96
000102     000          FWIND(I)=0.                                                      97
000103     000          NCLOS(I)=0                                                       98
000104     000    170   CONTINUE                                                         99
000105     000    C                                                                     100
000106     000    C     **************              END              *************     101
000107     000    C     ************************************************************     102
000108     000    C     ************** START OF THE INPUT PROGRAM      *************     103
000109     000    C     ************************************************************     104
000110     000    C                                                                     105
```

```
****** INH ******

000111     000          N7=N20                                                                     106
000112     000    180   CONTINUE                                                                   107
000113     000    C        READ ALL HYDRAULIC DATA CARDS AND ECHO WRITE THEM
000114     000          READ (N5,740) (ALPHA(I),I=1,20)                                            108
000115     000          WRITE (N6,750) (ALPHA(I),I=1,20)                                           109
000116     000    C        IS THIS THE END OF THE DATA DECK?
000117     000          IF (ALPHA(1).EQ.ASTERK) GO TO 190                                          110
000118     000    C     WRITE DATA TO SCRATCH FILE N24 TO BE USED FOR INPUT TO
000119     000    C                                                               THE CODE
000120     000          WRITE (N24,740) (ALPHA(I),I=1,20)                                          111
000121     000          GO TO 180                                                                  112
000122     000    190   CONTINUE                                                                   113
000123     000          WRITE (N6,760)                                                             114
000124     000          END FILE N24                                                               115
000125     000    C        REWIND SCRATCH FILE SO THAT THE CODE CAN READ FROM IT
000126     000          REWIND N24                                                                 116
000127     000    C        SET UP EQUIVALENCE SO THAT READING IS DONE FROM SCRATCH FILE
000128     000          N5=N24                                                                     117
000129     000    C                                                                                118
000130     000    C     *************** READ IN CARD GROUP H0               *************          119
000131     000    C          TITLE CARD 2
000132     000          READ (N5,770) ALPHA                                                        120
000133     000    C     ***************                END                  *************          121
000134     000    C                                                                                122
000135     000    C     ***************  READ IN CARD GROUP H1              *************          123
000136     000    C          HYDRAULIC CONTROL CARD
000137     000          READ (N5,780) NTCYC,PERIOD,QINT,DELT,EVAP,WIND,WDIR,NQSWRT,N               124
000138     000         1JSW,NJGW,NTRIB                                                             125
000139     000          EVAPM=EVAP
000140     000    C             CONVERT EVAP FROM MM/MONTH TO INCHES/MONTH
000141     000          EVAP=.03937*EVAP
000142     000          WINDM=WIND
000143     000    C             CONVERT WIND FROM METERS/SEC TO MPH
000144     000          WIND=2.236*WIND
000145     000          IF (NTRIB.LE.50) GO TO 200                                                 126
000146     000          WRITE (6,650) NTRIB                                                        127
000147     000          STOP                                                                       128
000148     000    200   CONTINUE                                                                   129
000149     000          IPERID=PERIOD+0.1                                                          130
000150     000          IQINT=QINT*3600.+0.1                                                       131
000151     000          IDELT=DELT+0.1                                                             132
000152     000          NQCYC=(IPERID*3600)/IQINT                                                  133
000153     000          NHCYC=IQINT/IDELT                                                          134
000154     000          NINT=(IPERID*3600)/IDELT                                                   135
000155     000          NPDEL=(NINT+50)/100                                                        136
000156     000          DELTQ=DELT*FLOAT(NHCYC)                                                    137
000157     000    C     ***************                END                  *************          138
000158     000    C                                                                                139
000159     000    C     *************** READ IN CARD GROUP H2               *************          140
000160     000    C         A LIST OF NJSW JUNCTION NUMBERS WHERE TIME-VARYING INFLOWS
000161     000    C               ARE LOCATED
000162     000          IF (NJSW.LE.0) GO TO 210                                                   141
000163     000          READ (N5,790) (JSW(L),L=1,NJSW)                                            142
000164     000    210   CONTINUE                                                                   143
000165     000    C     ***************                END                  *************          144
000166     000    C                                                                                145
000167     000    C     *************** READ IN CARD GROUP H3               *************          146
```

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******   INH   ******

000168      000   C         SPECIFY NJGW CONTROLLED NODE TYPES                                          147
000169      000         READ (N5,790) (JGW(I),I=1,NJGW)                                                148
000170      000   C     **************             END                       **************          149
000171      000   C                                                                                     150
000172      000   C     ************** READ IN CARD GROUP H4                 **************
000173      000   C     ********* ARE THERE ANY TIDAL FLATS ***********************************          151
000174      000         IF (NTRIB.LE.0) GO TO 230                                                      152
000175      000         DO 220 I=1,NTRIB
000176      000   C     ***** SPECIFY THE CHANNEL AND JUNCTION NUMBERS FOR THE TIDAL FLATS ***          153
000177      000         READ (N5,660) ITRIB(I,1),ITRIB(I,2)                                            154
000178      000   220   CONTINUE                                                                       155
000179      000   230   CONTINUE                                                                       156
000180      000   C     **************                   END                 **************          157
000181      000   C                                                                                     158
000182      000   C     ************** PRINT OUT PAGE ONE  THE CONTROL DATA  **************          159
000183      000         WRITE (N7,800) ALPHA                                                           160
000184      000         WRITE (N7,810) NTCYC                                                           161
000185      000         WRITE (N7,820) NOCYC                                                           162
000186      000         WRITE (N7,830) NHCYC                                                           163
000187      000         WRITE (N7,840) DELT
000188      000         WRITE (N7,710) EVAPM
000189      000   C                                                                                     166
000190      000         EVAP=EVAP/(12.*30.*86400.)
000191      000         WRITE (N7,860) WINDM,WDIR                                                      168
000192      000         WRITE (N7,870) NOSWRT                                                          169
000193      000         IF (NTRIB.LE.0) GO TO 240                                                      170
000194      000         WRITE (N7,670) NTRIB                                                           171
000195      000         WRITE (N7,680) (ITRIB(I,1),ITRIB(I,2),I=1,NTRIB)                               172
000196      000   240   CONTINUE                                                                       173
000197      000   C     **************             END                       **************          174
000198      000   C                                                                                     175
000199      000   C     ******************************************************************          176
000200      000   C     ************** READ  CARD GROUP H5                   **************          177
000201      000   C     ************** READ IN THE JUNCTION INFORMATION      **************          178
000202      000   C     ******************************************************************          179
000203      000         NJ=0                                                                           180
000204      000         DO 250 I=1,I75
000205      000         READ(N5,880) J,HEAD,SURF,QF1,QF2,DT                                            183
000206      000   C     ************** DID WE READ IN A CARD GROUP H6 CARD   **************          184
000207      000         IF (J.GT.I25) GO TO 260                                                        182
000208      000         DT=-DT
000209      000         HEADM(J)=HEAD
000210      000   C             CONVERT HEAD FROM METERS TO FEET
000211      000         HEAD=3.28*HEAD
000212      000         SURFM(J)=SURF
000213      000   C             CONVERT SURF FROM KM**2 TO MILLIONS OF SQ FEET
000214      000         SURF=10.744*SURF
000215      000         QF1M(J)=QF1
000216      000         QF2M(J)=QF2
000217      000   C             CONVERT QF1 AND QF2 FROM CUBIC METERS/SEC TO CFS
000218      000         QF1=35.314*QF1
000219      000         QF2=35.314*QF2
000220      000         DTM=DT
000221      000   C             CONVERT DT FROM METERS TO FEET
000222      000         DT=3.28*DT                                                                     185
000223      000         NJ=NJ+1                                                                        186
000224      000         IF (J.NE.NJ) WRITE (N6,720)
```

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******  INH  ******

000225     000          H(J)=HEAD                                                            187
000226     000          AS(J)=SURF                                                           188
000227     000          QIN(J)=QF1                                                           189
000228     000          QOU(J)=QF2                                                           190
000229     000    C         NOTE THAT VARIABLE DEP IS NOT RIVER DEPTH
000230     000          DEP(J)=DT                                                            193
000231     000    250   CONTINUE                                                             194
000232     000    260   CONTINUE                                                             195
000233     000    C         ARE THERE ANY JUNCTIONS WITH TIME-VARYING INFLOWS?
000234     000          IF (NJSW.LE.0) GO TO 280                                             196
000235     000          DO 270 L=1,NJSW                                                      197
000236     000          J=JSW(L)                                                             198
000237     000    270   QINST(L)=QIN(J)                                                      199
000238     000    280   CONTINUE                                                             200
000239     000    C     **************              END                  *************      201
000240     000    C                                                                          202
000241     000    C     ************************************************************        203
000242     000    C     ************** READ  CARD GROUP H7                *************      204
000243     000    C     ************** READ IN THE CHANNEL INFORMATION    *************      205
000244     000    C     ************************************************************        206
000245     000          NC=0                                                                 207
000246     000          DO 360 I=1,IZ9                                                       208
000247     000          READ (N5,890) N,(NTEMP(K),K=1,2),ALEN,WIDTH,RAD,COEF,VEL             209
000248     000    C     ************** DID WE READ IN A CARD GROUP H8 CARD   *************   211
000249     000          IF (N.GT.IZ9) GO TO 370                                              212
000250     000          RAD=-RAD                                                             210
000251     000          ALENM(I)=ALEN
000252     000    C         CONVERT ALEN FROM METERS TO FEET
000253     000          ALEN=3.28*ALEN
000254     000          WIDTHM(I)=WIDTH
000255     000    C            CONVERT WIDTH FROM METERS TO FEET
000256     000          WIDTH=3.28*WIDTH
000257     000          RADM(I)=RAD
000258     000    C            CONVERT RAD FROM METERS TO FEET
000259     000          RAD=3.28*RAD
000260     000          VELM(I)=VEL
000261     000    C            CONVERT VEL FROM METERS/SEC TO FPS
000262     000          VEL=3.28*VEL
000263     000          NC=NC+1                                                              213
000264     000          IF (N.NE.NC) WRITE (N6,900)                                          214
000265     000          N=NC                                                                 215
000266     000          LEN(N)=ALEN                                                          216
000267     000          B(N)=WIDTH                                                           217
000268     000          K=MAX0(NTEMP(1),NTEMP(2))                                            218
000269     000    C         CONVENTION USED ASSIGNS A NEGATIVE VALUE TO THE RIVER BOTTOM
000270     000    C               ELEVATION (RAD), WHEREAS HEAD (WATER SURFACE ELEVATION)
000271     000    C               AND WATER DEPTH ARE POSITIVE
000272     000    C         RIVER DEPTH IS EQUAL TO HEAD MINUS BOTTOM ELEVATION, BUT BECAUSE
000273     000    C               OF THE SIGN CONVENTION FOR THE LATTER (RAD), THE TWO TERMS
000274     000    C               ARE ADDED
000275     000          HYDRAD(N)=RAD+H(K)                                                   219
000276     000    C         CONVERT HYDRAD TO METRIC UNITS FOR OUTPUT
000277     000          HYDRAM(N) =HYDRAD(N)/3.28
000278     000          IFLAG=0                                                              220
000279     000          IF (NTRIB.LE.0) GO TO 310                                            221
000280     000          DO 290 IL=1,NTRIB                                                    222
000281     000          IF (N.EQ.ITRIB(IL,1)) GO TO 300                                      223
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BOTTOM OF IMAGE AREA OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
EPA Form 2350-4 (4-80)
(PREVIOUSLY CIN. EPA FORM 237)
TYPING GUIDE SHEET

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******   INH   ******
                                                                                     224
000282        000    290    CONTINUE                                                 225
000283        000           GO TO 310                                                226
000284        000    300    IFLAG=1                                                  227
000285        000           IJN=ITRIB(IL,2)
000286        000           TRBDEP(IL)=RAD
000287        000    C          CONVENTION USED ASSIGNS A NEGATIVE VALUE TO THE JUNCTION BOTTOM
000288        000    C               ELEVATION (DT=DEP), WHEREAS HEAD (WATER SURFACE ELEVATION)
000289        000    C               AND WATER DEPTH ARE POSITIVE
000290        000    C          RIVER DEPTH IS EQUAL TO HEAD MINUS BOTTOM ELEVATION, BUT BECAUSE
000291        000    C               OF THE SIGN CONVENTION FOR THE LATTER (DEP), THE TWO TERMS
000292        000    C               ARE ADDED                                           229
000293        000           HYDRAD(N)=H(IJN)+DEP(IJN)
000294        000    C          CONVERT HYDRAD TO METRIC UNITS FOR OUTPUT
000295        000           HYDRAM(N)= HYDRAD(N)/3.28                                230
000296        000    310    CONTINUE
000297        000    C          CROSS-SECTIONAL AREA = DEPTH*WIDTH                   231
000298        000           A(N)=HYDRAD(N)*WIDTH
000299        000           AM(N)=A(N)/10.744                                        232
000300        000           R(N)=RAD                                                 233
000301        000           AK(N)=COEF                                               234
000302        000           V(N)=VEL
000303        000    C          STORE THE NUMBERS OF THE JUNCTIONS AT EACH END OF CHANNEL N
000304        000    C               IN ARRAY NJUNC(N,I)                                 235
000305        000           NJUNC(N,1)=MIN0(NTEMP(1),NTEMP(2))                       236
000306        000           NJUNC(N,2)=MAX0(NTEMP(1),NTEMP(2))                       237
000307        000           K=NJUNC(N,1)                                             238
000308        000           IF (K.EQ.0) GO TO 360                                    239
000309        000           J=NJUNC(N,2)                                             240
000310        000           IF (IFLAG.EQ.1) GO TO 320
000311        000    C          CONVENTION USED ASSIGNS A NEGATIVE VALUE TO THE RIVER BOTTOM
000312        000    C               ELEVATION (RAD), WHEREAS HEAD (WATER SURFACE ELEVATION)
000313        000    C               AND WATER DEPTH ARE POSITIVE                        241
000314        000           HYDRAD(N)=RAD+(H(J)+H(K))/2.0
000315        000    C          CONVERT HYDRAD TO METRIC UNITS FOR OUTPUT
000316        000           HYDRAM(N)= HYDRAD(N)/3.28
000317        000    C          CROSS-SECTIONAL AREA = DEPTH*WIDTH                   242
000318        000           A(N)=HYDRAD(N)*WIDTH
000319        000           AM(N)=A(N)/10.744                                        243
000320        000    320    CONTINUE                                                 244
000321        000           DO 330 J=1,IZ6                                           245
000322        000           IF (IPOINT(K,J).EQ.NJUNC(N,2)) GO TO 350                 246
000323        000           IF (IPOINT(K,J).EQ.0) GO TO 340                          247
000324        000    330    CONTINUE                                                 248
000325        000    340    IPOINT(K,J)=NJUNC(N,2)                                   249
000326        000           NCHAN(K,J)=NC                                            250
000327        000           GO TO 360                                                251
000328        000    C      **************   THERE IS A REDUNDANT CHANNEL      *************  252
000329        000    350    NC=NC-1                                                  253
000330        000           WRITE (N6,730) N,M                                       254
000331        000           M=NCHAN(K,J)                                             255
000332        000           LEN(M)=ALEN                                              256
000333        000           B(M)=B(M)+WIDTH                                          257
000334        000           R(M)=RAD
000335        000    C          CROSS-SECTIONAL AREA = DEPTH*WIDTH                   258
000336        000           A(M)=HYDRAD(N)*B(M)
000337        000           AM(M)=A(M)/10.744                                        259
000338        000           HYDRAD(M)=HYDRAD(N)
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****** INH ******

000   C         CONVERT HYDRAD TO METRIC UNITS FOR OUTPUT
000             HYDRAM(N)= HYDRAD(N)/3.28
000             AK(M)=COEF
000             V(M)=VEL
000   360       CONTINUE
000   370       CONTINUE
000   C         **************               END                   *************
000   C
000   C         ************** OUTPUT PAGE TWO THE CHANNEL INFORMATION ***********
000             WRITE (N7,800) ALPHA
000             WRITE (N7,910)
000             DO 460 N=1,NC
000   C             ASSIGN DEFAULT VALUE OF 0.018 TO MANNING'S COEFFICIENT, UNLESS
000   C                  IT HAS BEEN PREVIOUSLY SPECIFIED
000             IF (AK(N).LE.0.0) AK(N)=0.018
000   C             DOES THIS CHANNEL HAVE A WIDTH GREATER THAN ZERO?
000             IF (B(N).GT.0.) GO TO 400
000             K=NJUNC(N,1)
000             NJUNC(N,1)=0
000             IDEL=0
000             DO 390 J=1,IZ6
000             IF (IPOINT(K,J).EQ.0) GO TO 390
000             IF (IPOINT(K,J).NE.NJUNC(N,2)) GO TO 380
000             WRITE (N7,920) N,K,NJUNC(N,2)
000             NCHAN(K,J)=0
000             IPOINT(K,J)=0
000             NJUNC(N,2)=0
000             GO TO 460
000   380       CONTINUE
000   390       CONTINUE
000   400       CONTINUE
000             K=NJUNC(N,2)
000             DO 430 J=1,IZ6
000             IF (IPOINT(K,J).EQ.NJUNC(N,1)) GO TO 410
000             GO TO 420
000   410       CONTINUE
000             IF (NJUNC(N,1).NE.0) GO TO 450
000   420       CONTINUE
000             IF (IPOINT(K,J).EQ.0) GO TO 440
000   430       CONTINUE
000   440       CONTINUE
000             IPOINT(K,J)=NJUNC(N,1)
000             NCHAN(K,J)=N
000   450       CONTINUE
000             TF=1000.
000             IF (R(N).GT.-2.) TF=0.75*LEN(N)/SQRT(32.2*(R(N)+2.))
000             XMK=BLANK
000             IF (TF.LT.DELT) XMK=ASTERK
000   C             WRITE CHANNEL DATA
000             WRITE (N7,930) N,ALENM(N),WIDTHM(N),AM(N),AK(N),VELM(N),HYDRAM(N)
000            1,(NJUNC(N,K),K=1,2),TF,XMK
000   460       CONTINUE
000   C         **************               END                   *************
000   C
000   C         ************** OUTPUT PAGE THREE JUNCTION INFORMATION*************
000             WRITE (N7,800) ALPHA
000             WRITE (N7,940)
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******  INH  ******
                                                                                     311
000396     000         ATOT=0.                                                       312
000397     000         DO 470 J=1,NJ
000398     000   C          USE ATOT TO SUM SURFACE AREAS                            313
000399     000         ATOT=ATOT+AS(J)
000400     000   C          WRITE JUNCTION DATA
000401     000         WRITE (N7,950) J,HEADM(J),SURFM(J),QF1M(J),QF2M(J),(NCHAN(J,K),K=1
000402     000        1,I26)                                                         316
000403     000   470   CONTINUE
000404     000   C          WRITE TOTAL SURFACE AREA
000405     000         ATOM=ATOT/10.744
000406     000         WRITE(N7,960) ATOM                                            318
000407     000   C     **************           END                 **************   319
000408     000   C                                                                   320
000409     000   C     ************** OUTPUT PAGE FOUR , CONTROL NODE INFORMATION ******* 321
000410     000         WRITE (N7,800) ALPHA
000411     000   C          THERE ARE NJGW CONTROLLED NODES                          322
000412     000         WRITE (N7,970) NJGW                                           323
000413     000         DO 580 J=1,NJGW                                               324
000414     000         DO 480 II=1,10                                                325
000415     000         A0(2,J,II)=0.
000416     000   C          ZERO OUT ARRAY A0                                        326
000417     000   480   A0(1,J,II)=0.                                                 327
000418     000         WRITE (N7,980) J                                              328
000419     000         IJK=JGW(J)
000420     000   C          WHAT TYPE OF CONTROLLED NODE?                            329
000421     000         GO TO (490,500,510,520,540,550), IJK                          330
000422     000   C                                                                   331
000423     000   C     **************        WIER TYPE CONTROLLED NODE    **************
000424     000   C          READ A TITLE CARD AND A DATA CARD                        332
000425     000   490   READ (N5,990) (ARRAY(I),I=1,20),A0(1,J,1),A0(1,J,2),A0(1,J,3)   333
000426     000         WRITE (N6,1000) (ARRAY(I),I=1,20),A0(1,J,1),A0(1,J,2),A0(1,J,3) 334
000427     000         WRITE (N7,1010) A0(1,J,1),A0(1,J,2),A0(1,J,3)
000428     000         CONTINUE                                                      335
000429     000         GO TO 580                                                     336
000430     000   C     **************           END                 **************   337
000431     000   C                                                                   338
000432     000   C     ************** A TIDALLY CONTROLLED NODE           **************
000433     000   C
000434     000   C          CALL TIDE TO READ DATA AND GENERATE REGRESSION COEFFICIENTS TO
000435     000   C                SIMULATE A TIDAL CYCLE
000436     000    500  CALL TIDE(ATEMP)
000437     000   C
000438     000   C          WRITE COEFFICIENTS
000439     000         DO 499 I=1,8
000440     000    499  ATIDE(I)=ATEMP(I)/3.28
000441     000         WRITE(N7,1020) (ATIDE(I),I=1,8)                               341
000442     000         GO TO 560                                                     342
000443     000   C     **************           END                 **************   343
000444     000   C                                                                   344
000445     000   C     ************** DAM WHICH IS OPERATED VIA A Q VS H POLICY *********
000446     000   C
000447     000   C          CALL REGRES TO READ DATA AND PERFORM REGRESSION          345
000448     000   510   CALL REGRES (ATEMP)
000449     000   C
000450     000   C   CONVERT COEFFICIENTS SO THAT THEY CORRESPOND TO METRIC VALUES
000451     000          A1=ATEMP(1)/35.314
000452     000          A2=ATEMP(2)/10.758
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****** INH ******
000            A3=ATEMP(3)/3.28
000            A4=ATEMP(4)
000            A5=ATEMP(5)*3.28
000            A6=ATEMP(6)*10.758
000            A8=ATEMP(8)*115.83
000            A7=ATEMP(7)*35.314
000            A9=ATEMP(9)*379.92
000            A10=ATEMP(10)*1246.14
000      C   PRINT THE METRIC EQUIVALENTS OF THE REGRESSION COEFFICIENTS
000            WRITE(N7,1030) A1,A2,A3,A4,A5,A6,A7,A8,A9,A10
000            GO TO 560
000      C     **************            END                         *************
000      C
000      C     **************  DAM WHERE THE Q VS T AND H VS T CURVES ARE KNOWN**
000      C      FIND H VS T FUNCTION
000      C
000       520  CHK=1.
000      C          CALL REGRES TO READ DATA AND PERFORM REGRESSION
000            CALL REGRES (ATEMP)
000            CHK=0.
000      C
000      C   CONVERT COEFFICIENTS SO THAT THEY CORRESPOND TO METRIC VALUES
000            A1=ATEMP(1)/3.28
000            A2=ATEMP(2)/3.28
000            A3=ATEMP(3)/3.28
000            A4=ATEMP(4)/3.28
000            A5=ATEMP(5)/3.28
000            A6=ATEMP(6)/3.28
000            A7=ATEMP(7)/3.28
000            A8=ATEMP(8)/3.28
000            A9=ATEMP(9)/3.28
000            A10=ATEMP(10)/3.28
000      C   PRINT THE METRIC EQUIVALENTS OF THE REGRESSION COEFFICIENTS
000            WRITE(N7,1040) A1,A2,A3,A4,A5,A6,A7,A8,A9,A10
000            DO 530 I=1,10
000      530   A0(2,J,I)=ATEMP(I)
000      C     ****************************************************************
000      C      FIND Q VS T FUNCTION
000      C
000            CHK=2.
000      C          CALL REGRES TO READ DATA AND PERFORM REGRESSION
000            CALL REGRES (ATEMP)
000            CHK=0.
000      C
000      C   CONVERT COEFFICIENTS SO THAT THEY CORRESPOND TO METRIC VALUES
000            A1=ATEMP(1)/35.314
000            A2=ATEMP(2)/35.314
000            A3=ATEMP(3)/35.314
000            A4=ATEMP(4)/35.314
000            A5=ATEMP(5)/35.314
000            A6=ATEMP(6)/35.314
000            A7=ATEMP(7)/35.314
000            A8=ATEMP(8)/35.314
000            A9=ATEMP(9)/35.314
000            A10=ATEMP(10)/35.314
000      C   PRINT THE METRIC EQUIVALENTS OF THE REGRESSION COEFFICIENTS
000            WRITE(N7,1050) A1,A2,A3,A4,A5,A6,A7,A8,A9,A10
```

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```
****** INH ******

 000          GO TO 560
 000   C      **************              END                     *************
 000   C
 000   C      ************** DAM WHERE THE H VS T CURVE IS KNOWN   *************
 000   C
 000   C           CALL REGRES TO READ DATA AND PERFORM REGRESSION
 000   540    CALL REGRES (ATEMP)
 000   C
 000   C    CONVERT COEFFICIENTS SO THAT THEY CORRESPOND TO METRIC VALUES
 000          A1=ATEMP(1)/3.28
 000          A2=ATEMP(2)/3.28
 000          A3=ATEMP(3)/3.28
 000          A4=ATEMP(4)/3.28
 000          A5=ATEMP(5)/3.28
 000          A6=ATEMP(6)/3.28
 000          A7=ATEMP(7)/3.28
 000          A8=ATEMP(8)/3.28
 000          A9=ATEMP(9)/3.28
 000          A10=ATEMP(10)/3.28
 000   C    PRINT THE METRIC EQUIVALENTS OF THE REGRESSION COEFFICIENTS
 000          WRITE(N7,1060) A1,A2,A3,A4,A5,A6,A7,A8,A9,A10
 000          GO TO 560
 000   C      **************              END                     *************
 000   C
 000   C      **************  DAM WHERE THE Q VS T CURVE IS KNOWN  *************
 000   C
 000   C           CALL REGRES TO READ DATA AND PERFORM REGRESSION
 000   550    CALL REGRES (ATEMP)
 000   C
 000   C    CONVERT COEFFICIENTS SO THAT THEY CORRESPOND TO METRIC VALUES
 000          A1=ATEMP(1)/35.314
 000          A2=ATEMP(2)/35.314
 000          A3=ATEMP(3)/35.314
 000          A4=ATEMP(4)/35.314
 000          A5=ATEMP(5)/35.314
 000          A6=ATEMP(6)/35.314
 000          A7=ATEMP(7)/35.314
 000          A8=ATEMP(8)/35.314
 000          A9=ATEMP(9)/35.314
 000          A10=ATEMP(10)/35.314
 000   C    PRINT THE METRIC EQUIVALENTS OF THE REGRESSION COEFFICIENTS
 000          WRITE(N7,1070) A1,A2,A3,A4,A5,A6,A7,A8,A9,A10
 000   C      **************              END                     *************
 000   C
 000   560    DO 570 I=1,10
 000   C           TRANSFER REGRESSION COEFFICIENTS TO ARRAY A0
 000   570    A0(1,J,I)=ATEMP(I)
 000   580    CONTINUE
 000   C      ****************************************************************
 000   C      **************              END                     *************
 000   C      ****************************************************************
 000   C
 000   C
 000   C      ************** OUTPUT PAGE FIVE ,HYDROGRAPH NODE INFORMATION *****
 000   C           ARE THERE TIME-VARYING INPUT NODES?
 000          IF (NJSW.LE.0) GO TO 610
 000          WRITE (N7,800) ALPHA
```

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```
****** INH ******                                                                      383
 000          WRITE (N7,1080) NJSW                                                     384
 000          DO 600 L=1,NJSW                                                          385
 000          J=JSW(L)                                                                 386
 000          WRITE (N7,1090) J
 000    C
 000          CHK=3.
 000    C         CALL REGRES TO READ DATA AND PERFORM REGRESSION                      387
 000          CALL REGRES (ATEMP)
 000          CHK=0.
 000    C
 000    C    CONVERT COEFFICIENTS SO THAT THEY CORRESPOND TO METRIC VALUES
 000          A1=ATEMP(1)/35.314
 000          A2=ATEMP(2)/35.314
 000          A3=ATEMP(3)/35.314
 000          A4=ATEMP(4)/35.314
 000          A5=ATEMP(5)/35.314
 000          A6=ATEMP(6)/35.314
 000          A7=ATEMP(7)/35.314
 000          A8=ATEMP(8)/35.314
 000          A9=ATEMP(9)/35.314
 000          A10=ATEMP(10)/35.314
 000    C    PRINT THE METRIC EQUIVALENTS OF THE REGRESSION COEFFICIENTS
 000          WRITE(N7,1100) A1,A2,A3,A4,A5,A6,A7,A8,A9,A10                            389
 000          DO 590 I=1,10
 000    C         TRANSFER REGRESSION COEFFICIENTS TO ARRAY A0                         390
 000    590   A0(3,L,I)=ATEMP(I)                                                       391
 000    600   CONTINUE                                                                 392
 000    610   CONTINUE                                                ************** 393
 000    C     **************               END                                         394
 000    C                                                             ************** 395
 000    C     **************  PREPARE HYDRODYNAMIC INPUT TAPE                          396
 000          WRITE (N7,1110) ASTERK                                                   397
 000          WRITE (N7) NTCYC,PERIOD,QINT,DELT,WIND,WDIR,NQSWRT,NJSW,NJGW             398
 000         1,(JSW(L),QINST(L),((A0(I,L,N),I=1,3),N=1,10),L=1,IZ12),(JGW(L),L=1      399
 000         2,IZ13),(ALPHA(I),I=1,30),NQCYC,NHCYC,NT,DELTQ,ICYC,NCYC,NEXIT,NJ,N      400
 000         3C,((NCHAN(I,II),IPOINT(I,II),II=1,IZ6),H(I),H(I),H(I),H(I),H(I),AS      401
 000         4(I),VOL(I),X(I),Y(I),DEP(I),QIN(I),QOU(I),QIN(I),QOU(I),I=1,NJ),((      402
 000         5NJUNC(N,L),L=1,2),LEN(N),B(N),R(N),A(N),A(N),AK(N),Q(N),Q(N),Q(N),      403
 000         6V(N),V(N),V(N),FWIND(N),NCLOS(N),N=1,NC),EVAP,NTRIB,(TRBDEP(I),ITR
 000         7IB(I,1),ITRIB(I,2),I=1,50),HYDEND
 000    C    *** HYDEND IS A SPECIAL CASE FOR THE EPA PESTICIDE STUDY ***
 000          IF (NTRIB .EQ. 0) GO TO 621
 000          WRITE(6,690) NTRIB                                                       406
 000          DO 620 I=1,NTRIB
 000          TRBDM=TRBDEP(I)/3.28
 000          WRITE(6,700) ITRIB(I,1),ITRIB(I,2),TRBDM
 000    620   CONTINUE                                                                 409
 000    621   CONTINUE                                                                 410
 000          END FILE N7                                                              411
 000          REWIND N7                                               ************** 412
 000    C     **************               END                                         413
 000    C
 000    C
 000    C           PRINT OUT THE HYDRODYNAMIC INPUT DATA
 000          READ(N7,1110)ZDUMMY                                                      416
 000    630   READ (N7,1120) ARRAY                                                     417
 000          IF (ARRAY(1).EQ.ASTERK) GO TO 640
```

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******   INH   ******
                                                                                              418
000624        000         WRITE (N6,1120) ARRAY                                               419
000625        000         GO TO 630                                                           420
000626        000   640   WRITE (N6,1130)                                                     421
000627        000         N5=5
000628        000         RETURN                                                              425
000629        000   C                                                                         426
000630        000   C                                                                          427
000631        000   C     ************** FORMAT STATEMENT 950 MUST BE CHANGED  *************  428
000632        000   C     ************** WHENEVER PARAMETER I76 IS CHANGED     *************  429
000633        000   C                                                                         430
000634        000   C                                                                         431
000635        000   C
000636        000   650    FORMAT (' YOU REQUESTED TOO MANY TIDE FLATS' /,I5,' TO BE EXACT(JO 433
000637        000         1B ABORTED) '//)                                                    434
000638        000   660    FORMAT (2I5)
000639        000   670    FORMAT(' THIS PROBLEM HAS',I5,' TIDE FLAT CHANNEL(S).'/'   THEY(IT  436
000640        000         1) ARE(IS)'/' CHANNEL NO.    CHARACTERISTIC'/15X,'JUNCTION NUMBER   437
000641        000         2 '//)                                                              438
000642        000   680    FORMAT (I10,10X,I5)
000643        000   690    FORMAT(//,1X,'THERE ARE',I5,' TIDE FLAT CHANNELS',/)
000644        000   700    FORMAT(3X,'CHANNEL',I3,' IS A TIDE FLAT CHANNEL, WITH NODE',I3,' B
000645        000         1EING THE TIDE FLAT.',2X,' BOTTOM ELEVATION OF THE CHANNEL IS '
000646        000         2,1PE12.5  )
000647        000   710    FORMAT (1H0,'THE EVAPORATION RATE IS ',1PE10.3,'    (MM/MONTH)')     442
000648        000   720    FORMAT (' THE JUNCTION INFORMATION IS OUT OF ORDER')               443
000649        000   730    FORMAT ('CHANNELS',I5,' AND',I5,' ARE REDUNDANT')                  444
000650        000   740    FORMAT (20A4)                                                      445
000651        000   750    FORMAT (26X,20A4)                                                  446
000652        000   760    FORMAT (1H1)                                                       447
000653        000   770    FORMAT (15A4)                                                      448
000654        000   780    FORMAT (I5,3F5.0,5X,3F5.0,4I5)                                     449
000655        000   790    FORMAT (20I5)                                                      450
000656        000   800    FORMAT (1H1,15A4,20X,20HBATTELLE NORTHWEST  ,/1X,15A4,19X,21H RICH 451
000657        000         1LAND, WASHINGTON,/,80X,20H HYDRODYNAMIC MODEL ,//)                 452
000658        000   810    FORMAT (15H0DAYS SIMULATED,I4)                                     453
000659        000   820    FORMAT (29H0WATER QUALITY CYCLES PER DAY,I4)                       454
000660        000   830    FORMAT (43H0INTEGRATION CYCLES PER WATER QUALITY CYCLE,I4)         455
000661        000   840    FORMAT (30H0LENGTH OF INTEGRATION STEP IS,F6.0,8H SECONDS)         457
000662        000   860    FORMAT (15H0WIND VELOCITY,F5.0,22H M/SEC WIND DIRECTION,F5.0,19H D 458
000663        000         1EGREES FROM NORTH)                                                 459
000664        000   870    FORMAT (26H0WRITE CYCLE STARTS AT THE,I4,11H TIME CYCLE//)
000665        000   880    FORMAT (I5,F10.2,-6PF10.2,0P2F10.2,F10.2)                          461
000666        000   890    FORMAT (3I5,10X,5F10.0)                                            462
000667        000   900    FORMAT (45H CHANNEL INPUT INFORMATION OUT OF ORDER      )          463
000668        000   910    FORMAT (108H CHANNEL   LENGTH   WIDTH    AREA    MANNING  VELOCI   464
000669        000         1TY   HYD RADIUS          JUNCTIONS AT ENDS   MAX INT/67H  NUMBER   465
000670        000         2    (M)       (M)     (M**2)    COEF.     (MPS)         (M)/,31X,' 466
000671        000         3X .001'/)                                                          467
000672        000   920    FORMAT (8H CHANNEL,I4,8H JOINING,I4,4H AND,I4,38H DELETED DUE TO Z 468
000673        000         1ERO OR NEGATIVE WIDTH)                                             469
000674        000   930    FORMAT (I5,F11.0,F8.0,-3PF10.0,0PF9.3,F10.2,F13.1,I19,I6,F16.0,1X, 470
000675        000         1A4)                                                                471
000676        000   940    FORMAT (124H JUNCTION   INITIAL HEAD   SURFACE AREA    INPUT    OU
000677        000         1TPUT              CHANNELS ENTERING JUNCTION
000678        000         2   /122H  NUMBER          (M)           (SQUARE KM)    (CMS)     (CMS
                                                                                    /
000679        000         3)                                                                  475
000680        000         4)
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****** INH ******

000  950   FORMAT (I7,F13.2,-6PF15.2,0P2F10.0,I10,5I6)
000  960   FORMAT (E20.6)                                                          477
000  970   FORMAT (//,18H THIS PROBLEM HAS ,I5,20H CONTROLLED NODES    ,/)         478
000  980   FORMAT (16H0JUNCTION NUMBER,I5)                                         479
000  990   FORMAT (20A4,/3F10.0)                                                   480
000  1000  FORMAT (1H1,20A4/30H THE INPUT WEIR CONSTANTS ARE /5H A1= ,E10.4,2      481
000        1X,5H A2= ,E10.4,2X,5H A3= ,E10.4//)                                    482
000  1010  FORMAT (1H+,22X,10H IS A WEIR/34H THE CONTROLLING WEIR FORMULA IS       483
000        1 ,' DELH=DELT/AREA*(INFLOW-A1*(HEAD-A2+DELH/2)**A3)',/,1X,'WHERE A
000        21 = ',E12.5,' ,A2 = ',E12.5,' ,A3 = ',E12.5,/,1X,'AND THE CONSTANT
000        3S CORRESPOND TO METRIC DATA')
000  1020  FORMAT (1H+,22X,30H IS A TIDALLY INFLUENCED NODE /50H THE PERIODIC      486
000        1 STAGE-TIME HISTORY IS GIVEN BY       /' H(T)=0.5*A1 + A2*COS(T) +
000        2A3*COS(2*T) + A4*COS(3*T) + A5*SIN(T) + A6*SIN(2*T) + A7*SIN(3*T)
000        3+ A8*SIN(4*T) ',/,' WHERE A1=',E10.4,',  A2=',E10.4,',  A3=',E10.4
000        4,',  A4=',E10.4,',  A5=',E10.4,',  A6=',E10.4,',  A7=',E10.4,',  A
000        58=',E10.4,/,1X,'AND THE CONSTANTS CORRESPOND TO METRIC DATA')
000  1030  FORMAT (1H+,22X,55H IS A DAM WHICH IS OPERATED ACCORDING TO A Q VS      491
000        1 H CURVE/62H THE CONTROLLING Q VS H CURVE IS FIT BY THE FOLLOWING      492
000        2FUNCTION/76H Q=A1+A2*H+A3*H**2+A4*H**3+A5*H**4+A6*H**5+A7*H**6+A8*     493
000        3H**7+A9*H**8+A10*H**9 /11H WHERE A1= ,E10.4,6H, A2= ,E10.4,6H, A3=     494
000        4 ,E10.4,6H, A4= ,E10.4,6H, A5= ,E10.4,/7X,4HA6= ,E10.4,6H, A7= ,E1     495
000        50.4,6H, A8= ,E10.4,6H, A9= ,E10.4,7H, A10= ,E10.4,/,1X,'AND THE CO
000        6NSTANTS CORRESPOND TO METRIC DATA')
000  1040  FORMAT (1H+,22X,60H IS A DAM WHOSE HEAD AND OUTFLOW ARE KNOWN FUNC      497
000        1TIONS OF TIME,/57H THE HEAD VS TIME CURVE IS FIT BY THE FOLLOWING      498
000        2FUNCTION /76H H=A1+A2*T+A3*T**2+A4*T**3+A5*T**4+A6*T**5+A7*T**6+A8     499
000        3*T**7+A9*T**8+A10*T**9 /11H WHERE A1= ,E10.4,6H, A2= ,E10.4,6H, A3     500
000        4= ,E10.4,6H, A4= ,E10.4,6H, A5= ,E10.4,/7X,4HA6= ,E10.4,6H, A7= ,E     501
000        510.4,6H, A8= ,E10.4,6H, A9= ,E10.4,7H, A10= ,E10.4,/,1X,'AND THE C
000        6ONSTANTS CORRESPOND TO METRIC DATA')
000  1050  FORMAT (39H THE OUTFLOW VS TIME CURVE IS FIT BY   /76H Q=A1+A2*T+A      503
000        13*T**2+A4*T**3+A5*T**4+A6*T**5+A7*T**6+A8*T**7+A9*T**8+A10*T**9 /1     504
000        21H WHERE A1= ,E10.4,6H, A2= ,E10.4,6H, A3= ,E10.4,6H, A4= ,E10.4,6     505
000        3H, A5= ,E10.4,/7X,4HA6= ,E10.4,6H, A7= ,E10.4,6H, A8= ,E10.4,6H, A     506
000        49= ,E10.4,7H, A10= ,E10.4,/,1X,'AND THE CONSTANTS CORRESPOND TO ME
000        5TRIC DATA')
000  1060  FORMAT (1H+,22X,50H IS A DAM WHOSE HEAD IS A KNOWN FUNCTION OF TIM      508
000        1E  ,/57H THE HEAD VS TIME CURVE IS FIT BY THE FOLLOWING FUNCTION ,     509
000        2/76H H=A1+A2*T+A3*T**2+A4*T**3+A5*T**4+A6*T**5+A7*T**6+A8*T**7+A9*     510
000        3T**8+A10*T**9 /11H WHERE A1= ,E10.4,6H, A2= ,E10.4,6H, A3= ,E10.4,     511
000        46H, A4= ,E10.4,6H, A5= ,E10.4,/7X,4HA6= ,E10.4,6H, A7= ,E10.4,6H,      512
000        5A8= ,E10.4,6H, A9= ,E10.4,7H, A10= ,E10.4,/,1X,'AND THE CONSTANTS
000        6CORRESPOND TO METRIC DATA')
000  1070  FORMAT (1H+,22X,50H IS A DAM WHOSE FLOW IS A KNOWN FUNCTION OF TIM      514
000        1E  ,/57H THE FLOW VS TIME CURVE IS FIT BY THE FOLLOWING FUNCTION ,     515
000        2/76H Q=A1+A2*T+A3*T**2+A4*T**3+A5*T**4+A6*T**5+A7*T**6+A8*T**7+A9*     516
000        3T**8+A10*T**9 /11H WHERE A1= ,E10.4,6H, A2= ,E10.4,6H, A3= ,E10.4,     517
000        46H, A4= ,E10.4,6H, A5= ,E10.4,/7X,4HA6= ,E10.4,6H, A7= ,E10.4,6H,      518
000        5A8= ,E10.4,6H, A9= ,E10.4,7H, A10= ,E10.4,/,1X,'AND THE CONSTANTS
000        6CORRESPOND TO METRIC DATA')
000  1080  FORMAT (//,18H THIS PROBLEM HAS ,I5,21H HYDROGRAPH INPUTS    ,/)       520
000  1090  FORMAT (16H0JUNCTION NUMBER,I5)                                         521
000  1100  FORMAT (1H+,22X,30H IS A HYDROGRAPH INPUT NODE    /62H THE HYDROGRA     522
000        1PH INPUT CURVE IS FIT BY THE FOLLOWING FUNCTION  /76H Q=A1+A2*T+A3     523
000        2*T**2+A4*T**3+A5*T**4+A6*T**5+A7*T**6+A8*T**7+A9*T**8+A10*T**9 /11     524
000        3H WHERE A1= ,E10.4,6H, A2= ,E10.4,6H, A3= ,E10.4,6H, A4= ,E10.4,6H     525
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 ******  INH  ******

000738      000          4, A5= ,E10.4,/7X,4HA6= ,E10.4,6H, A7= ,E10.4,6H, A8= ,E10.4,6H, A9     526
000739      000          5= ,E10.4,7H, A10= ,E10.4,/,1X,'AND THE CONSTANTS CORRESPOND TO MET
000740      000          6RIC DATA')
000741      000    1110   FORMAT (A4)
000742      000    1120   FORMAT (33A4)                                                           528
000743      000    1130   FORMAT (35H1END OF HYDRODYNAMIC INPUT PROGRAM )                         529
000744      000           END                                                                     530

END ELT.

@HDG,P  ******  MAIN  ******
```

```
****** MAIN ******

@ELT.L IMAINT.MAIN


000  C     ************** MAIN PROGRAM FOR EXPLORE-1 INPUT     *************
000  C     ************** BATTELLE NORTHWEST 11/9/71           *************
000  C     ****************************************************************
000  C      THIS PROGRAM CALLS INH
000  C
000  C         THIS EXECUTIVE PROGRAM MAKES I/O ASSIGNMENTS AND CALLS
000  C              THE MAIN INPUT SUBROUTINE INH
000  C
000  C
000  C     ************** ASSIGN THE COMMON  DATA               *************
000        COMMON /TAPES/N5,N6,N20,N22,N24
000        COMMON/PARAMS/IZ5,IZ6,IZ9,IZ12,IZ13
000  C
000  C     ************** CONTROL AND TITLE INFORMATION        *************
000        COMMON /PTINT/ NJ,NC,NJGW,NTCYC,NQSWRT,NQCYC,DELTQ,PERIOD,
000       1ALPHA(30),DEP(70),IPOINT(70,6),AS(70),EVAP
000        COMMON/QUAL/NCHAN(70,6),LEN(100),NJUNC(100,2),JGW(20)
000  C
000        REAL LEN
000  C
000  C     *************  ASSIGN THE UNIT NUMBERS AND REWIND    *************
000  C
000        IZ5=70
000        IZ6=6
000        IZ9=100
000        IZ12=20
000        IZ13=20
000  C
000        N5=5
000        N6=6
000        N20=2
000  C     THE UNIVAC 1100 DOES NOT ALLOW THE USE OF LOGICAL UNIT 1 SINCE IT IS
000  C     THE SYSTEM PUNCH FILE.
000        N24 = 4
000  C
000        REWIND N20
000        REWIND N24
000  C     **************                END                    *************
000  C
000  C     **************  HYDRAULIC INPUT                      *************
000  C
000        CALL INH
000  C
000        REWIND N24
000        REWIND N20
000  C     **************                END                    *************
000        STOP
000        END

END ELT.

@HDG,P ****** PICTUR ******
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****** PICTUR ******

```
*ELT,L IMAINT.PICTUR

000             SUBROUTINE PICTUR (N,M,MCOL,XX,YY,ARK,ISYM,CARD1)
000     C        THIS ROUTINE IS CALLED BY REGRES AND CALLS SORT AND SORDER
000     C       PROGRAMMED BY JE SCHLOSSER  1965  MODIFIED BY CA OSTER  1966          2
000     C       PRESENTS A PICTURE OF DATA ON PRINTED OUTPUT, TWO OPTIONS BEING       3
000     C       AVAILABLE                                                             4
000     C          1   MCOL POSITIVE                                                  5
000     C          2   MCOL NEGATIVE, IN WHICH CASE XINCREMENTS ARE TAKEN AS EQUAL    6
000     C               TO Y INCREMENTS AS DETERMINED BY M                            7
000     C                                                                             8
000     C       DICTIONARY                                                            9
000     C                                                                            10
000     C          VARIABLE   DEFINITION                                             11
000     C             N       NUMBER OF POINTS TO PLOT      (MAXIMUM OF 500)         12
000     C             M       MAXIMUM NUMBER OF LINES                                13
000     C             MCOL    MAXIMUM NUMBER OF COLUMNS                              14
000     C                                                                            15
000     C            XX(I)    X COORDINATE FOR ITH POINT                             16
000     C            YY(I)    Y COORDINATE FOR ITH POINT                             17
000     C            ARK(I)   MARKER FOR ITH POINT                                   18
000     C            ISYM(I)  PRIORITY DESIGNATOR FOR MARKER USED ON I-TH POINT      19
000     C                           (LOWER SUBSCRIPT INDICATES HIGHER PRIORITY)      20
000     C                                                                            21
000     C                                                                            22
000             DIMENSION XX(2),YY(2),XYM(3,500),PX(6),ALF(107),ARK(2),              23
000            1ILF(107),ISYM(5),IXYM(3,500)                                         24
000             DIMENSION CARD1(20)
000             EQUIVALENCE (ILF,ALF),(BLANK,LANKBA),(IXYM,XYM)                      26
000     C                                                                            27
000             EXTERNAL SORDER                                                      30
000             DATA BLANK/1H  /                                                     28
000     C                                                                            29
000             N=MAX0(MIN0(500,N),2)                                                31
000             XYM(1,2)=1.01                                                        32
000             XYM(2,2)=1.01                                                        33
000             XYM(3,2)=BLANK                                                       34
000             XMIN=1.0E37                                                          35
000             XMAX=-1.0E37                                                         36
000             DO 100 I=1,N                                                         37
000             XYM(1,I)=XX(I)                                                       38
000             XYM(2,I)=YY(I)                                                       39
000             XYM(3,I)=ARK(I)                                                      40
000             XMIN=AMIN1(XMIN,XYM(1,I))                                            41
000             XMAX=AMAX1(XMAX,XYM(1,I))                                            42
000     100     CONTINUE                                                             43
000             CALL SORT (XYM,N,3,SORDER)                                           44
000             YMIN=XYM(2,N)                                                        45
000             YMAX=XYM(2,1)                                                        46
000             DYLOG=ALOG10(10./FLOAT(M)*1.0E5)                                     47
000             IF ((YMAX-YMIN).EQ.0.) GO TO 110                                     48
000             DYLOG=ALOG10((YMAX-YMIN)/FLOAT(M)*1.0E5)                             49
000     110     CONTINUE                                                             50
000             APROX=DYLOG-AINT(DYLOG)                                              51
000             DO 120 I=2,10                                                        52
```

```
******  PICTUR  ******

000054     000          FI=!                                               53
000055     000          IF (APROX-ALOG10(FI)) 130,130,120                  54
000056     000   120    CONTINUE                                           55
000057     000   130    EXACT=FI*10.0**(INT(DYLOG)-5)                      56
000058     000          IF (MCOL) 200,140,140                              57
000059     000   140    DXLOG=ALOG10((XMAX-XMIN)/FLOAT(MCOL/2)*1.0E5)      58
000060     000          XAPROX=DXLOG-AINT(DXLOG)                           59
000061     000          IF (XAPROX-.3010) 150,150,160                      60
000062     000   150    XEXACT=2.0*10.0**(INT(DXLOG)-5)                    61
000063     000          GO TO 190                                          62
000064     000   160    IF (XAPROX-.6990) 170,170,180                      63
000065     000   170    XEXACT=5.0*10.0**(INT(DXLOG)-5)                    64
000066     000          GO TO 190                                          65
000067     000   180    XEXACT=10.0**(INT(DXLOG)-4)                        66
000068     000   190    CONTINUE                                           67
000069     000          XACT=XEXACT/2.0                                    68
000070     000          GO TO 210                                          69
000071     000   200    XACT=EXACT/2.0                                     70
000072     000   210    TENX=20.0*XACT                                     71
000073     000          TENE=10.0*EXACT                                    72
000074     000          MAXYI=(YMAX/TENE)+(0.5+SIGN(0.5,YMAX))             73
000075     000          MAXXI=(XMAX/TENX)+(0.5+SIGN(0.5,XMAX))             74
000076     000          MINYI=(YMIN/TENE)-(0.5+SIGN(0.5,-YMIN))            75
000077     000          MINXI=(XMIN/TENX)-(0.5+SIGN(0.5,-XMIN))            76
000078     000          YFIRST=TENE*FLOAT(MAXYI)                           77
000079     000          XFIRST=TENX*FLOAT(MINXI)                           78
000080     000          LINES=10*(MAXYI-MINYI)+1                           79
000081     000          KOLS=20*(MAXXI-MINXI)                              80
000082     000          IF (KOLS-500) 230,230,220                          81
000083     000   220    WRITE (6,490) KOLS                                 82
000084     000          KOLS=500                                           83
000085     000   230    IF (LINES-401) 250,250,240                         84
000086     000   240    WRITE (6,500)                                      85
000087     000          RETURN                                             86
000088     000   250    CONTINUE                                           87
000089     000          LEAF=(KOLS+99)/100                                 88
000090     000          DO 430 L=1,LEAF                                    89
000091     000          DO 260 I=1,6                                       90
000092     000          PX(I)=5.*TENX*FLOAT(L-1)+TENX*FLOAT(I-1)+XFIRST    91
000093     000   260    CONTINUE                                           92
000094     000          WRITE (6,440) CARD1                                93
000095     000          WRITE (6,480) PX                                   94
000096     000          WRITE (6,470)                                      95
000097     000          DEX=XACT/2.0                                       96
000098     000          DEL=EXACT/2.0                                      97
000099     000          DDD=DEX+2.0*XACT                                   98
000100     000          J=1                                                99
000101     000          DO 420 I=1,LINES                                  100
000102     000          YPLOT=YFIRST-EXACT*FLOAT(I-1)                     101
000103     000          DO 270 JKL=1,107                                  102
000104     000   270    ALF(JKL)=BLANK                                    103
000105     000   280    IF (J-N) 290,290,380                              104
000106     000   290    IF (XYM(1,J)-PX(1)) 370,300,300                   105
000107     000   300    CONTINUE                                          106
000108     000          IF (XYM(2,J)-(YPLOT+DEL)) 310,310,380             107
000109     000   310    IF (XYM(2,J)-(YPLOT-DEL)) 380,320,320             108
000110     000   320    CONTINUE                                          109
```

```
******  PICTUR  ******

000111      000           IF (XYM(1,J)-PX(6)-DDD) 330,330,370
000112      000     330   CONTINUE
000113      000           KOL=INT((XYM(1,J)+DEX-PX(1))/XACT)+4
000114      000           IF ((KOL.GT.107).OR.(KOL.LT.1)) GO TO 370
000115      000           IXYM3J=IXYM(3,J)
000116      000           ILFKOL=ILF(KOL)
000117      000           IF (ILFKOL.EQ.LANKBA) GO TO 360
000118      000           ISYM1=0
000119      000           ISYM2=0
000120      000           DO 340 IIYY=1,5
000121      000           IF (ILFKOL.EQ.ISYM(IIYY)) ISYM1=IIYY
000122      000           IF (IXYM3J.EQ.ISYM(IIYY)) ISYM2=IIYY
000123      000     340   CONTINUE
000124      000           ISYMM=MIN0(ISYM1,ISYM2)
000125      000           IF (ISYMM) 370,370,350
000126      000     350   ILF(KOL)=ISYM(ISYMM)
000127      000           GO TO 370
000128      000     360   ALF(KOL)=XYM(3,J)
000129      000     370   J=J+1
000130      000           GO TO 280
000131      000     380   CONTINUE
000132      000           IF (MOD(I-1,10).NE.0) GO TO 390
000133      000           WRITE (6,450) YPLOT,ALF
000134      000           GO TO 410
000135      000     390   IF (MOD(I-1,5).NE.0) GO TO 400
000136      000           WRITE (6,510) ALF
000137      000           GO TO 410
000138      000     400   WRITE (6,460) ALF
000139      000     410   CONTINUE
000140      000     420.  CONTINUE
000141      000           WRITE (6,470)
000142      000           WRITE (6,480) PX
000143      000     430   CONTINUE
000144      000           RETURN
000145      000     C
000146      000     C
000147      000     C
000148      000     440   FORMAT (///////10X,19A4,A2///)
000149      000     450   FORMAT (1X,F9.3,2H *,107A1,1H*)
000150      000     460   FORMAT (11X,1HI,107A1,1HI)
000151      000     470   FORMAT (1H0,14X,1H*,5(20H - - - - + - - - - - *),/,1H )
000152      000     480   FORMAT (11X,F7.2,5(13X,F7.2))
000153      000     490   FORMAT (48H0ONLY THE FIRST 500 COLUMNS OF A PLOT REQUIRING I3,25H
000154      000          1COLUMNS WILL BE PRINTED.)
000155      000      500  FORMAT(1X,'THERE IS A LIMIT OF 400 LINES')
000156      000     510   FORMAT (11X,1H+,107A1,1H+)
000157      000           END

END ELT.

@HDG,P  ******  0  ******
```

```
****** Q ******

@ELT.L IMAINT.Q

000001        000          FUNCTION Q (B,C)
000002        000    C       THIS FUNCTION IS CALLED BY SORT
000003        000          DIMENSION B(5), C(5)
000004        000          Q=C(2)-B(2)
000005        000          RETURN
000006        000          END

END ELT.

@HDG.P  ******  REGR  ******
```

****** REGR ******

```
@ELT,L IMAINT.REGR

000          FUNCTION REGR(M,X,Y,N,A,B)
000    C      THIS FUNCTION IS CALLED BY REGRES AND CALLS SIMUL
000    C        FUNCTION REGR, WHICH CARRIES OUT AN NTH-ORDER POLYNOMIAL
000    C        REGRESSION ON M DATA POINTS CONTAINED IN THE X AND Y ARRAYS.
000    C        THE FUNCTION NORMALLY RETURNS THE STANDARD DEVIATION S OF THE
000    C        POINTS ABOUT THE REGRESSION CURVE.  THE REGRESSION COEFFICIENTS
000    C        ARE PLACED IN A AND B(1)...B(N).   HOWEVER, IF THE SIMULTANEOUS
000    C        EQUATION SOLVING ROUTINE SIMUL ENCOUNTERS A NEAR-SINGULAR
000    C        MATRIX, THE FUNCTION RETURNS THE VALUE 0.0
000    C
000    C     C........MATRIX CONTAINING THE COEFFICIENTS
000    C     CYX......C(I,Y) VECTOR
000    C     CYY......C(Y,Y) VECTOR
000    C     DET......DETERMINANT OF THE COEFFICIENT MATRIX C.
000    C     EPS......TOLERANCE USED BY THE FUNCTION SIMUL
000    C     SIMUL....FUNCTION FOR SOLVING SIMULTANEOUS EQUATIONS
000    C     SX,SYX...VECTOR CONTAINING SUMMATIONS X**I AND X**I * Y
000    C     SY,SYY...VECTOR CONTAINING SUMMATIONS Y AND Y**2
000    C
000          DIMENSION C(51,51),SX(100),SYX(51),CYX(51),X(100),Y(100),B(51)
000          DATA EPS/ 1.0E-20/
000          DATA MM/100/,NN/51/
000    C
000    C     ..... COMPUTE SUMS OF POWERS AND PRODUCTS .....
000          NTWO=2*N
000          NP1=N+1
000          SY=0.0
000          SYY=0.0
000          DO 100 I=1,N
000          NPI=N+I
000          SX(I)=0.0
000          SX(NPI)=0.0
000    100   SYX(I)=0.0
000          DO 120 I=1,M
000          SY=SY+Y(I)
000          SYY=SYY+Y(I)**2
000          DUM=1.0
000          DO 110 J=1,N
000          DUM=DUM*X(I)
000          SX(J)=SX(J)+DUM
000    110   SYX(J)=SYX(J)+Y(I)*DUM
000          DO 120 J=NP1,NTWO
000          DUM=DUM*X(I)
000    120   SX(J)=SX(J)+DUM
000    C
000    C     ..... COMPUTE COEFFICIENTS C(I,J) .....
000          FM=FLOAT(M)
000          CYY=SYY-SY*SY/FM
000          DO 130 I=1,N
000          CYX(I)=SYX(I)-SY*SX(I)/FM
000          C(I,NP1)=CYX(I)
000          DO 130 J=1,N
000          IPJ=I+J
```

```
****** REGR ******

000054        000   130    C(I,J)=SX(IPJ)-SX(I)*SX(J)/FM                                           53
000055        000   C                                                                              54
000056        000   C      ..... CALL ON SIMUL TO SOLVE SIMULTANEOUS EQUATIONS .....               55
000057        000          DET=SIMUL(N,C,B,EPS,1,NN)                                               56
000058        000          WRITE (6,160) DET                                                       57
000059        000          IF (DET.NE.0.0) GO TO 140                                               58
000060        000          REGR=0.0                                                                59
000061        000          RETURN                                                                  60
000062        000   C                                                                              61
000063        000   C      ..... COMPUTE INTERCEPT A AND STANDARD DEVIATION S .....                62
000064        000   140    DUM=SY                                                                  63
000065        000          TEMP=CYY                                                                64
000066        000          DO 150 I=1,N                                                            65
000067        000          DUM=DUM-B(I)*SX(I)                                                      66
000068        000   150    TEMP=TEMP-B(I)*CYX(I)                                                   67
000069        000          A=DUM/FM                                                                68
000070        000          DENOM=FLOAT(M)-FLOAT(N)-1.0                                             69
000071        000          S=ABS(TEMP/DENOM)                                                       70
000072        000          S=DSQRT(S)                                                              71
000073        000          IF (S.EQ.0.) S=EPS                                                      72
000074        000          REGR=S                                                                  73
000075        000          RETURN                                                                  74
000076        000   C                                                                              75
000077        000   C                                                                              76
000078        000   C                                                                              77
000079        000   160    FORMAT (13H0      DET = ,E14.8)                                         78
000080        000          END                                                                      -

END ELT.

@HDG,P  ******  REGRES  ******
```

```
****** REGRES ******

@ELT,L IMAINT.REGRES


000          SUBROUTINE REGRES (ATEMP)
000    C      THIS ROUTINE IS CALLED BY INH AND CALLS PICTUR AND REGR
000    C        POLYNOMIAL REGRESSION WITH PLOTTING.
000    C
000    C        THIS MAIN PROGRAM READS THE HORIZONTAL AND VERTICAL COORDINATES
000    C        OF M DATA POINTS INTO THE X AND Y ARRAYS.   THE LEAST AND
000    C        GREATEST VALUES OF X SHOULD BE STORED IN X(1) AND X(M) RESPEC-
000    C        TIVELY.   THE FUNCTION REGR IS USED TO PERFORM SUCCESSIVE NTH-
000    C        ORDER REGRESSIONS, FROM N = MIN THROUGH N = MAX.   IN EACH
000    C        CASE, THE REGRESSION CURVE IS PLOTTED AGAINST THE ORIGINAL
000    C        DATA POINTS.
000    C
000    C     A........REGRESSION COEFFICIENT(INTERCEPT)
000    C     B........VECTOR CONTAINING REGRESSION COEFFICIENTS
000    C     DELTAX...X-SPACING FOR 26 POINTS ON THE REGRESSION CURVE
000    C     M........NUMBER OF DATA POINTS
000    C     MAX,MIN..UPPER AND LOWER LIMITS ON ORDER OF REGRESSION
000    C     N........ORDER, N, OF POLYNOMIAL REGRESSION
000    C     REGR.....FUNCTION FOR PERFORMING NTH ORDER REGRESSION
000    C     S........STANDARD DEVIATION OF THE POINTS ABOUT THE REGRESSION
000    C              LINE.  IF SIMUL ENCOUNTERS A NEAR-SINGULAR MATRIX, S IS
000    C              RETURNED ZERO AS A WARNING.
000    C     X,Y......VECTORS CONTAINING THE X AND Y COORDINATES OF THE DATA
000    C              POINTS.
000    C
000          COMMON /TAPES/N5,N6,N7,N18,N20,N22,N24
000    C   *** HYDEND IS A SPECIAL CASE FOR THE EPA PESTICIDE STUDY ***
000          COMMON /NEW/ IJK,CHK,XM(20),YM(20),HYDEND
000          DIMENSION ARRAY(50)
000          DIMENSION X(100),Y(100),B(55),ARK(100),ISYM(5),CARD4(20)
000          DIMENSION ATEMP(10)
000    C   *** HYDEND IS A SPECIAL CASE FOR THE EPA PESTICIDE STUDY ***
000          NAMELIST /CARD1/ M,MIN,MAX,X,Y,HYDEND
000          DATA  STAR/1H*/
000          DATA ASTER/4H****/
000          DATA CONST/4H CON/
000          DATA ARRAY/1H1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9,2H10,2H11,2H12,2H13
000         1,2H14,2H15,2H16,2H17,2H18,2H19,2H20,2H21,2H22,2H23,2H24,2H25,2H26,
000         22H27,2H28,2H29,2H30,2H31,2H32,2H33,2H34,2H35,2H36,2H37,2H38,2H39,2
000         3H40,2H41,2H42,2H43,2H44,2H45,2H46,2H47,2H48,2H49,2H50/
000          DATA MMM/100/,NN/55/,III/25/,JJJ/100/
000    C
000    C      CARD1 IS TITLE CARD FOR PLOTTING
000    C      READ AND CHECK COORDINATES X(1)...X(M), Y(1)...Y(M),
000    C      AND LOWEST AND HIGHEST ORDERS MIN AND MAX
000    C
000    C      CHK IS A DUMMY VARIABLE
000    C      CHK = 1 REGRES WAS CALLED TO FIND H FOR Q VS T AND H VS T DAM
000    C      CHK = 2 REGRES WAS CALLED TO FIND Q FOR Q VS T AND H VS T DAM
000    C      CHK = 3 REGRES WAS CALLED TO EVALUATE HYDROGRAPH NODES
000         A=0.0
000         DO 100 I=1,NN
000    100  B(I)=0.0
```

```
******  REGRES  ******

000         READ (N5,310) CARD4                                                   46
000         WRITE (6,310) CARD4                                                   47
000         IF(CARD4(1).NE.CONST) GO TO 110
000         DECODE (18,220,CARD4(1)) A
001         IF(CHK.EQ.3.)  GO TO 105
001         GO TO (200,200,101,102,103,104),IJK
001   C
001   C     Q IS CONSTANT (Q VS H)
000   C      STORE METRIC VALUE IN AM, CONVERT A TO ENGLISH UNITS
000     101 AM=A
000         A=35.314*A
000         GO TO 200
000   C
000   C      STORE METRIC VALUE IN AM, CONVERT A TO ENGLISH UNITS
000     102 AM=A
000         IF (CHK .EQ. 2.) GO TO 202
000   C      H IS CONSTANT (Q VS T AND H VS T)
000         A=3.28*A
000         GO TO 200
000   C
000   C      Q IS CONSTANT (Q VS T AND H VS T)
000   C      STORE METRIC VALUE IN AM, CONVERT A TO ENGLISH UNITS
000    202  A=35.314*A
000         GO TO 200
000   C
000   C      H IS CONSTANT (H VS T)
000   C      STORE METRIC VALUE IN AM, CONVERT A TO ENGLISH UNITS
000     103 AM=A
000         A=3.28*A
000         GO TO 200
000   C
000   C      Q IS CONSTANT (Q VS T)
000   C      STORE METRIC VALUE IN AM, CONVERT A TO ENGLISH UNITS
000     104 AM=A
000         A=35.314*A
000         GO TO 200
000   C
000   C      HYDROGRAPH INPUT IS CONSTANT
000   C      STORE METRIC VALUE IN AM, CONVERT A TO ENGLISH UNITS
000     105 AM=A
000         A=35.314*A
000         GO TO 200                                                             50
000   C*****THE FOLLOWING ELEMENT MUST BE REMADE IN THE PROGRAM,SEE APPENDIX
000   C*****G.7 IN FORTRAN(ASCII) MANUAL, TO ALLOW A NAMELIST READ FROM A
000   C*****LOGICAL UNIT OTHER THAN 5 ON THE UNIVAC 1100.
000   C*****  @ASM,SI IMAINT.F2SCT
000   C*****         F$SCT  33,111,0
000   C*****         END
000   110   READ (N5,CARD1,ERR=211,END=212)                                       51
000         IF (MAX.LT.MIN) MAX=MIN                                               52
000         IF (MIN.GE.(M-1)) GO TO 120                                           53
000         IF (MAX.GE.(M-1)) MAX=M-1                                             54
000         GO TO 1201
000   120   MAX=M-1                                                               56
000         MIN=MAX                                                               57
000   1201  IF (CHK .EQ. 3.) GO TO 125
000   C      CHECK THE TYPE OF CONTROLLED NODE
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```
****** REGRES ******
000          GO TO (130,130,121,122,123,124), IJK
000      121 CONTINUE
000   C        Q VS H
000          DO 221 I=1,M
000          XM(I)=X(I)
000          YM(I)=Y(I)
000          X(I)=3.28*X(I)
000      221 Y(I)=35.314*Y(I)
000          GO TO 130
000      122 CONTINUE
000   C        H VS T AND Q VS T
000          IF(CHK .GT. 1.) GO TO 322
000   C        CONVERT H FROM METERS TO FEET
000          DO 222 I=1,M
000          XM(I)=X(I)
000          YM(I)=Y(I)
000      222 X(I)=3.28*X(I)
000          GO TO 130
000      322 CONTINUE
000          IF (CHK .GT. 2.) GO TO 125
000   C        CONVERT Q FROM CMS TO CFS
000          DO 422 I=1,M
000          XM(I)=X(I)
000          YM(I)=Y(I)
000      422 X(I)=35.314*X(I)
000          GO TO 130
000      123 CONTINUE
000   C        H VS T
000   C        CONVERT H FROM METERS TO FEET
000          DO 223 I=1,M
000          XM(I)=X(I)
000          YM(I)=Y(I)
000      223 X(I)=3.28*X(I)
000          GO TO 130
000      124 CONTINUE
000   C        Q VS T
000   C        CONVERT Q FROM CMS TO CFS
000          DO 224 I=1,M
000          XM(I)=X(I)
000          YM(I)=Y(I)
000      224 X(I)=35.314*X(I)
000          GO TO 130
000      125  CONTINUE
000   C        HYDROGRAPH NODE INFORMATION
000   C        CONVERT FLOWS FROM CMS TO CFS
000          DO 225 I=1,M
000          XM(I)=X(I)
000          YM(I)=Y(I)
000   225    Y(I)=35.314*Y(I)
000   130    CONTINUE
000          IF (MIN.LE.0) MIN=1
000          IF (MAX.LE.0) MAX=1
000          IF(CARD4(19).EQ.ASTER) GO TO 140
000   C
000          WRITE(6,260) M,(XM(I),YM(I),I=1,M)
000          WRITE (6,270) MIN,MAX
000   140    CONTINUE
```

BEGIN LAST LINE OF TEXT
3/8"
BOTTOM OF IMAGE AREA, OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS

```
******  REGRES  ******
                                                                                    66
000168     000          DO 150 I=1,M                                                67
000169     000    150   ARK(I)=STAR                                                 68
000170     000          ISYM(1)=STAR                                                69
000171     000          DO 190 N=MIN,MAX
000172     000          IF(CARD4(19).EQ.ASTER) GO TO 160                            71
000173     000          WRITE (6,250) CARD4                                         72
000174     000          WRITE (6,280) N                                             73
000175     000    160   CONTINUE                                                    74
000176     000    C
000177     000    C      USE FUNCTION REGR TO PERFORM NTH-ORDER REGRESSION          76
000178     000    C                                                                 77
000179     000          S=REGR(M,X,Y,N,A,B)                                         78
000180     000          IF (S.NE.0.0) GO TO 170                                     79
000181     000          WRITE (6,290) CARD4                                         80
000182     000          GO TO 190                                                   81
000183     000    170   CONTINUE
000184     000          IF(CARD4(19).EQ.ASTER) GO TO 190
000185     000          WRITE(6,300) S,AM,(I,B(I),I=1,N)                            84
000186     000    C
000187     000    C      COMPUTE 26 POINTS LYING ON REGRESSION CURVE                86
000188     000    C                                                                 87
000189     000          DELTAX=(X(M)-X(1))/25.0                                     88
000190     000          MP1=M+1                                                     89
000191     000          MP26=M+26                                                   90
000192     000          DO 180 I=MP1,MP26                                           91
000193     000          STEPS=FLOAT(I)-FLOAT(M)-1.0                                 92
000194     000          X(I)=X(1)+STEPS*DELTAX                                      93
000195     000          Y(I)=A                                                      94
000196     000          ARK(I)=ARRAY(N)                                             95
000197     000          DO 180 J=1,N                                                96
000198     000    180   Y(I)=Y(I)+B(J)*X(I)**J                                      97
000199     000          ISYM(2)=ARRAY(N)                                            98
000200     000    C
000201     000    C      PLOT REGRESSION CURVE AGAINST ORIGINAL POINTS             100
000202     000    C                                                                101
000203     000          CALL PICTUR (M+26,III,JJJ,X,Y,ARK,ISYM,CARD4)              102
000204     000    190   CONTINUE                                                   103
000205     000    200   CONTINUE                                                   104
000206     000          ATEMP(1)=A                                                 105
000207     000          DO 210 I=2,10                                              106
000208     000    210   ATEMP(I)=B(I-1)                                            107
000209     000          RETURN                                                      108
000210     000    211   WRITE (6,230) CARD4                                        109
000211     000          STOP                                                        110
000212     000    212   WRITE (6,240) CARD4                                        111
000213     000          STOP                                                       112
000214     000    C
000215     000    C      FORMATS FOR INPUT AND OUTPUT STATEMENTS                   114
000216     000    C                                                                115
000217     000    C                                                                116
000218     000    C
000219     000    220   FORMAT (6X,F12.1)
000220     000    230   FORMAT (' ERROR IN NAMELIST INPUT TO REGRES '/,20A4)
000221     000    240   FORMAT (' END OF FILE ENCOUNTERED IN REGRES '/,20A4)
000222     000    250   FORMAT (1H ,20A4)                                          121
000223     000    260   FORMAT (34H  POLYNOMIAL REGRESSION, WITH M = ,I2,12H DATA POINTS//   122
000224     000         18X,5H X(I),8X,5H Y(I)//(2F13.2))
```

```
 ******  REGRES  ******
                                                                                      123
000225        000   270   FORMAT (58H0 THE LOWEST AND HIGHEST ORDER POLYNOMIALS TO BE TRIED   124
000226        000        1ARE//6X,7H MIN = ,I3,5X,7H MAX = ,I3)                               125
000227        000   280   FORMAT (32H  POLYNOMIAL REGRESSION OF ORDER/1H0,5X,7H N   = ,I3)      126
000228        000   290   FORMAT (69H0 MATRIX C IS NEAR-SINGULAR.   REGRESSION COEFFICIENTS
000229        000        1NOT DETERMINED/1H 20A4)                                              128
000230        000   300   FORMAT (1H0,5X,5H S = ,F10.6/6X,5H A = ,F10.6//(6X,3H B(,I2,4H) =   129
000231        000        1,F11.6))
000232        000   310   FORMAT (20A4)
000233        000         END

END ELT.

@HDG,P  ******  SIMUL  ******
```

```
****** SIMUL ******

@ELT,L IMAINT.SIMUL

000            FUNCTION SIMUL (N,A,X,EPS,INDIC,NRC)
000   C         THIS FUNCTION IS CALLED BY REGR
000   C
000   C           WHEN INDIC IS NEGATIVE, SIMUL COMPUTES THE INVERSE OF THE N BY
000   C           N MATRIX A IN PLACE.  WHEN INDIC IS ZERO, SIMUL COMPUTES THE
000   C           N SOLUTIONS X(1)...X(N) CORRESPONDING TO THE SET OF LINEAR
000   C           EQUATIONS WITH AUGMENTED MATRIX OF COEFFICIENTS IN THE N BY
000   C           N+1 ARRAY A AND IN ADDITION COMPUTES THE INVERSE OF THE
000   C           COEFFICIENT MATRIX IN PLACE AS ABOVE.  IF INDIC IS POSITIVE,
000   C           THE SET OF LINEAR EQUATIONS IS SOLVED BUT THE INVERSE IS NOT
000   C           COMPUTED IN PLACE. THE GAUSS-JORDAN COMPLETE ELIMINATION METHOD
000   C           IS EMPLOYED WITH THE MAXIMUM PIVOT STRATEGY.  ROW AND COLUMN
000   C           SUBSCRIPTS OF SUCCESSIVE PIVOT ELEMENTS ARE SAVED IN ORDER IN
000   C           THE IROW AND JCOL ARRAYS RESPECTIVELY.  K IS THE PIVOT COUNTER,
000   C           PIVOT THE ALGEBRAIC VALUE OF THE PIVOT ELEMENT, MAX
000   C           THE NUMBER OF COLUMNS IN A AND DETER THE DETERMINANT OF THE
000   C           COEFFICIENT MATRIX.  THE SOLUTIONS ARE COMPUTED IN THE (N+1)TH
000   C           COLUMN OF A AND THEN UNSCRAMBLED AND PUT IN PROPER ORDER IN
000   C           X(1)...X(N) USING THE PIVOT SUBSCRIPT INFORMATION AVAILABLE
000   C           IN THE IROW AND JCOL ARRAYS.  THE SIGN OF THE DETERMINANT IS
000   C           ADJUSTED, IF NECESSARY, BY DETERMINING IF AN ODD OR EVEN NUMBER
000   C           OF PAIRWISE INTERCHANGES IS REQUIRED TO PUT THE ELEMENTS OF THE
000   C           JORD ARRAY IN ASCENDING SEQUENCE WHERE JORD(IROW(I)) = JCOL(I).
000   C           IF THE INVERSE IS REQUIRED, IT IS UNSCRAMBLED IN PLACE USING
000   C           Y(1)...Y(N) AS TEMPORARY STORAGE.  THE VALUE OF THE DETERMINANT
000   C           IS RETURNED AS THE VALUE OF THE FUNCTION.  SHOULD THE POTENTIAL
000   C           PIVOT OF LARGEST MAGNITUDE BE SMALLER IN MAGNITUDE THAN EPS,
000   C           THE MATRIX IS CONSIDERED TO BE SINGULAR AND A TRUE ZERO IS
000   C           RETURNED AS THE VALUE OF THE FUNCTION.
000   C
000   C       A.........AUGMENTED MATRIX OF COEFFICIENTS, A=(AIJ)
000   C       DETER....DETERMINANT OF THE ORIGINAL COEFFICIENT MATRIX
000   C       EPS......MINIMUM ALLOWABLE MAGNITUDE FOR A PIVOT ELEMENT
000   C       I,J......ROW AND COLUMN SUBSCRIPTS,RESP.
000   C       INDIC....COMPUTATIONAL SWITCH
000   C       MAX......NUMBER OF COLUMNS IN A,EITHER N OR N+1
000   C       N........NUMBER OF ROWS IN A
000   C       X........VECTOR OF SOLUTIONS
000   C
000   C       AIJCK....AIC(K)
000   C       INTCH....NUMD
000   C       INTCH....NUMBER OF PAIRWISE INTERCHANGES REQ'D TO ORDER J-VECTOR
000   C       IP1,KM1,NM1...I+1, K-1, AND N-1, RESP.
000   C       IROW.....VECTOR OF PIVOT ELEMENT ROW SUBSCRIPTS, R(K)
000   C       ICOL.....VECTOR OF PIVOT ELEMENT COLUMN SUBSCRIPTS, C(K)
000   C       IROWI,IROWJ,IROWK
000   C       JCOLI,JCOLJ,JCOLK...R(I),R(J),R(K),C(I),C(J),C(K), RESP.
000   C       ISCAN,JSCAN...INDICES USED IN PIVOT SEARCH OF VECTORS C AND R
000   C       JORD.....THE J VECTOR
000   C       JTEMP....TEMPORARY VARIABLE USED IN ORDERING THE J VECTOR
000   C       K........CYCLE COUNTER AND PIVOT ELEMENT SUBSCRIPT
000   C       NRC......ROW AND COLUMN DIMENSIONS OF STORAGE FOR THE A-MATRIX
000   C       PIVOT....PIVOT ELEMENT
```

```
000  C     Y........VECTOR USED IN UNSCRAMBLING THE INVERSE MATRIX
000  C
000        DIMENSION IROW(50),JCOL(50),JORD(50),Y(50),A(NRC,NRC),X(50)
000  C
000        MAX=N
000        IF (INDIC.GE.0) MAX=N+1
000  C
000  C     .....IS N LARGER THAN 50 .....
000        IF (N.LE.50) GO TO 100
000        WRITE (6,250)
000        SIMUL=0.
000        RETURN
000  C
000  C     ..... BEGIN ELIMINATION PROCEDURE .....
000  100   DETER=1.
000        DO 170 K=1,N
000        KM1=K-1
000  C
000  C     ..... SEARCH FOR THE PIVOT ELEMENT .....
000        PIVOT=0.
000        DO 130 I=1,N
000        DO 130 J=1,N
000  C     ..... SCAN IROW AND JCOL ARRAYS FOR INVALID PIVOT SUBSCRIPTS .....
000        IF (K.EQ.1) GO TO 120
000        DO 110 ISCAN=1,KM1
000        DO 110 JSCAN=1,KM1
000        IF (I.EQ.IROW(ISCAN)) GO TO 130
000  110   IF (J.EQ.JCOL(JSCAN)) GO TO 130
000  120   IF (DABS(A(I,J)).LE.DABS(PIVOT)) GO TO 130
000        PIVOT=A(I,J)
000        IROW(K)=I
000        JCOL(K)=J
000  130   CONTINUE
000  C
000  C     ..... INSURE THAT SELECTED PIVOT IS LARGER THAN EPS .....
000        IF (DABS(PIVOT).GT.EPS) GO TO 140
000        SIMUL=0.
000        RETURN
000  C
000  C     ..... UPDATE THE DETERMINANT VALUE .....
000  140   IROWK=IROW(K)
000        JCOLK=JCOL(K)
000        DETER=DETER*PIVOT
000  C
000  C     ..... NORMALIZE PIVOT ROW ELEMENTS .....
000        DO 150 J=1,MAX
000  150   A(IROWK,J)=A(IROWK,J)/PIVOT
000  C
000  C     ..... CARRY OUT ELIMINATION AND DEVELOP INVERSE .....
000        A(IROWK,JCOLK)=1./PIVOT
000        DO 170 I=1,N
000        AIJCK=A(I,JCOLK)
000        IF (I.EQ.IROWK) GO TO 170
000        A(I,JCOLK)=-AIJCK/PIVOT
000        DO 160 J=1,MAX
000  160   IF (J.NE.JCOLK) A(I,J)=A(I,J)-AIJCK*A(IROWK,J)
000  170   CONTINUE
```

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```
****** SIMUL ******
          000    C
          000    C        ..... ORDER SOLUTION VALUES (IF ANY) AND CREATE JORD ARRAY .....
          000             DO 180 I=1,N
          000             IROWI=IROW(I)
          000             JCOLI=JCOL(I)
          000             JORD(IROWI)=JCOLI
          000    180      IF (INDIC.GE.0) X(JCOLI)=A(IROWI,MAX)
          000    C
          000    C        ..... ADJUST SIGN OF DETERMINANT .....
          000             INTCH=0
          000             NM1=N-1
          000             DO 190 I=1,NM1
          000             IP1=I+1
          000             DO 190 J=IP1,N
          000             IF (JORD(J).GE.JORD(I)) GO TO 190
          000             JTEMP=JORD(J)
          000             JORD(J)=JORD(I)
          000             JORD(I)=JTEMP
          000             INTCH=INTCH+1
          000    190      CONTINUE
          000             IF (INTCH/2*2.NE.INTCH) DETER=-DETER
          000    C
          000    C        ..... IF INDIC IS POSITIVE RETURN WITH RESULTS .....
          000             IF (INDIC.LE.0) GO TO 200
          000             SIMUL=DETER
          000             RETURN
          000    C
          000    C        ..... IF INDIC IS NEGATIVE OR ZERO, UNSCRAMBLE THE INVERSE
          000    C              FIRST BY ROWS .....
          000    200      DO 220 J=1,N
          000             DO 210 I=1,N
          000             IROWI=IROW(I)
          000             JCOLI=JCOL(I)
          000    210      Y(JCOLI)=A(IROWI,J)
          000             DO 220 I=1,N
          000    220      A(I,J)=Y(I)
          000    C        ..... THEN BY COLUMNS .....
          000             DO 240 I=1,N
          000             DO 230 J=1,N
          000             IROWJ=IROW(J)
          000             JCOLJ=JCOL(J)
          000    230      Y(IROWJ)=A(I,JCOLJ)
          000             DO 240 J=1,N
          000    240      A(I,J)=Y(J)
          000    C
          000    C        ..... RETURN FOR INDIC NEGATIVE OR ZERO .....
          000             SIMUL=DETER
          000             RETURN
          000    C
          000    C        ..... FORMAT FOR OUTPUT STATEMENT .....
          000    C
          000    C
          000    C
          000    250      FORMAT (10HON TOO HIG)
          000             END

END ELT.
```

```
****** SORDER ******

@ELT,L IMAINT.SORDER


000001      000          FUNCTION SORDER (FIRST,SECOND)
000002      000    C      THIS FUNCTION IS CALLED BY SORT
000003      000          DIMENSION FIRST(3),SECOND(3)
000004      000          SORDER=FIRST(2)-SECOND(2)
000005      000          RETURN
000006      000          END

END ELT.

@HDG,P  ******  SORT  ******
```

```
****** SORT ******

@ELT,L IMAINT.SORT

000         SUBROUTINE SORT (M,N,ITEM,Q)
000   C      THIS ROUTINE IS CALLED BY PICTUR AND CALLS Q AND SORDER
000   C
000   C     ALGORITHM 245 -  TREESORT 3   FROM ACM, DEC. 1964
000   C                                         VOL 7   NUMBER 12, PAGE 701
000   C
000   C     PROGRAMMED BY JE SCHLOSSER
000   C
000   C
000   C     GENERAL PURPOSE INTERNAL SORT SUBROUTINE
000   C
000   C     EXAMPLE OF USE - - -   ASSUME -   N ITEMS OF 5 WORDS EACH
000   C                                       TO BE SORTED IN ASCENDING
000   C                                       ORDER ON THE SECOND WORD.
000   C
000   C     MAIN PROGRAM
000   C     DIMENSION A(5,1000)    N IS LESS THAN OR EQUAL TO 1000
000   C                            A CONTAINS THE ITEMS TO BE SORTED
000   C
000   C     EXTERNAL Q        Q IS A FUNCTION SUBROUTINE WHICH WILL RETURN
000   C                       A POSITIVE NUMBER IF THE FIRST ITEM (FIRST
000   C      .                ARGUMENT) IS TO SORT AHEAD OF THE  SECOND
000   C      .                ITEM (SECOND ARGUMENT).   SEE EXAMPLE BELOW.
000   C      .
000   C
000   C     CALL SORT (A,N,5,Q)   ARGUMENT    MEANING
000   C                            FIRST      ARRAY CONTAINING ITEMS
000   C      .                     SECOND     NUMBER OF ITEMS
000   C      .                     THIRD      NUMBER OF WORDS PER ITEM
000   C      .                     FOURTH     FUNCTION SUBROUTINE TO
000   C      .                                         DEFINE SORT ORDER
000   C      .
000   C
000   C     FUNCTION Q(B,C)           WRITE A FUNCTION SUBROUTINE SUCH AS THIS.
000   C     DIMENSION B(5),C(5)       IT SHOULD RETURN A POSITIVE RESULT IF
000   C     Q=C(2)-B(2)               THE FIRST ARGUMENT SHOULD SORT AHEAD
000   C     RETURN                    OF THE SECOND ARGUMENT.  THIS ROUTINE
000   C     END                       PRODUCES AN ASCENDING SORT ON THE SECOND
000   C                               WORD  OF THE ITEMS.
000   C
000   C     NOTE - -  THE MAXIMUM NUMBER OF WORDS PER ITEM IS LIMITED
000   C     BY THE DIMENSION OF KOPY.     THIS LIMIT IS PRESENTLY 100.
000   C
000   C     APPROXIMATE SPEED IS 250 ITEMS PER SECOND.
000         INTEGER Q
000         DIMENSION KOPY (100)
000         DIMENSION M(ITEM,N)
000         IF (N-1) 320,320,100
000   100   K=N/2+1
000         L=N/2-1
000         IF (L) 210,210,110
000   110   CONTINUE
000         DO 200 II=1,L
000         I=K-II
000         IS=I
000         NS=N
```

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```
******  SORT  ******

000054       000          DO 120 IQ=1,ITEM                                                   53
000055       000    120   KOPY(IQ)=M(IQ,IS)                                                  54
000056       000    130   J=2*IS                                                             55
000057       000          IF (J.GT.NS) GO TO 180                                             56
000058       000          IF (J.GE.NS) GO TO 150                                             57
000059       000          IF (Q(M(1,J+1),M(1,J))) 140,150,150                                58
000060       000    140   J=J+1                                                              59
000061       000    150   IF (Q(M(1,J),KOPY)) 160,180,180                                    60
000062       000    160   DO 170 IQ=1,ITEM                                                   61
000063       000    170   M(IQ,IS)=M(IQ,J)                                                   62
000064       000          IS=J                                                               63
000065       000          GO TO 130                                                          64
000066       000    180   DO 190 IQ=1,ITEM                                                   65
000067       000    190   M(IQ,IS)=KOPY(IQ)                                                  66
000068       000    200   CONTINUE                                                           67
000069       000    210   NPLUS=N+2                                                          68
000070       000          DO 310 II=2,N                                                      69
000071       000          I=NPLUS-II                                                         70
000072       000          IS=1                                                               71
000073       000          NS=I                                                               72
000074       000          DO 220 IQ=1,ITEM                                                   73
000075       000    220   KOPY(IQ)=M(IQ,IS)                                                  74
000076       000    230   J=2*IS                                                             75
000077       000          IF (J.GT.NS) GO TO 280                                             76
000078       000          IF (J.GE.NS) GO TO 250                                             77
000079       000          IF (Q(M(1,J+1),M(1,J))) 240,250,250                                78
000080       000    240   J=J+1                                                              79
000081       000    250   IF (Q(M(1,J),KOPY)) 260,280,280                                    80
000082       000     260   DO 270 IQ=1,ITEM                                                  81
000083       000    270   M(IQ,IS)=M(IQ,J)                                                   82
000084       000          IS=J                                                               83
000085       000          GO TO 230                                                          84
000086       000    280   DO 290 IQ=1,ITEM                                                   85
000087       000    290   M(IQ,IS)=KOPY(IQ)                                                  86
000088       000          DO 300 IT=1,ITEM                                                   87
000089       000          LAZY=M(IT,1)                                                       88
000090       000          M(IT,1)=M(IT,I)                                                    89
000091       000          M(IT,I)=LAZY                                                       90
000092       000    300   CONTINUE                                                           91
000093       000    310   CONTINUE                                                           92
000094       000    320   CONTINUE                                                           93
000095       000          RETURN                                                             94
000096       000          END                                                                -

END ELT.

@HDG,P  ******  TIDE  ******
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```
****** TIDE ******

@ELT,L IMAINT.TIDE

000           SUBROUTINE TIDE (FEET)
000    C        THIS ROUTINE IS CALLED BY INH AND CALLS GAUSS
000    C   THIS PROGRAM USES GAUSSIAN ELIMINATION TO GENERATE
000    C   AN EXPRESSION FOR TIDAL HEIGHT
000    C
000    C
000    C       INPUT CONSISTS OF TCYC, THE LENGTH OF THE TIDAL CYCLE IN HOURS,
000    C       AS WELL AS THE HEIGHT IN METERS OF THE HIGH HIGH, LOW LOW,
000    C       LOW HIGH, AND HIGH LOW TIDES.  THE TIMES AT WHICH THESE TIDES
000    C       OCCUR ARE INPUT IN DECIMAL FORM AND STORED IN THE ARRAY 'T',
000    C       WHILE THE HEIGHTS ARE STORED IN THE ARRAY 'TIDH'
000            DIMENSION A(8,9), T(4), TIDH(4), THETA(4), RESULT(8),FEET(8)
000            DIMENSION TITLE(33),TT(50),YY(50)
000            COMMON /PTINT/ NJ,NC,NJGW,NTCYC,NQSWRT,NQCYC,DELTQ,PERIOD,
000           1ALPHA(30),DEP(70),IPOINT(70,6),AS(70),EVAP
000            COMMON/NEW/IJK,CHK,XM(20),YM(20)
000            EQUIVALENCE (TT(4),T(4)),(TIDH(4),YY(4))
000    C       ************** NAMELIST CARDS FOR INPUT OF DATA      **************
000            NAMELIST /CARD1/ TT,YY
000    C          SET N5=1 SO THAT INPUT WILL BE FROM SCRATCH FILE
000            N5=1
000            N6=6
000    C          SET LENGTH OF CYCLE
000            TCYC=PERIOD
000            READ (N5,320) (TITLE(I),I=1,20)
000            WRITE (N6,330) (TITLE(I),I=1,20)
000            READ (N5,CARD1,ERR=291,END=292)
000    C       CONVERT TIMES TO ANGLES IN RADIANS
000            DO 10 IA=1,4
000         10 THETA(IA)=T(IA)*2.*3.14159/TCYC
000    C    SET UP MATRIX 'A' OF COEFFICIENTS
000            DO 30 IB=1,8
000            IC=IB-4
000            IF(IC .LE. 0) GO TO 20
000    C    FOR EQUATIONS USING F'(X)
000            A(IB,1)=0.0
000            A(IB,2)=-SIN(THETA(IC))
000            A(IB,3)=-2.*SIN(2.*THETA(IC))
000            A(IB,4)=-3.*SIN(3.*THETA(IC))
000            A(IB,5)=COS(THETA(IC))
000            A(IB,6)=2.*COS(2.*THETA(IC))
000            A(IB,7)=3.*COS(3.*THETA(IC))
000            A(IB,8)=4.*COS(4.*THETA(IC))
000            A(IB,9)=0.0
000            GO TO 30
000    C    FOR EQUATIONS USING F(X)
000         20 A(IB,1)=0.5
000            A(IB,2)=COS(THETA(IB))
000            A(IB,3)=COS(2.*THETA(IB))
000            A(IB,4)=COS(3.*THETA(IB))
000            A(IB,5)=SIN(THETA(IB))
000            A(IB,6)=SIN(2.*THETA(IB))
000            A(IB,7)=SIN(3.*THETA(IB))
```

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```
******   TIDE   ******

      000             A(IB,8)=SIN(4.*THETA(IB))
      000             A(IB,9)=TIDH(IB)
      000          30 CONTINUE
      000       C
      000             CALL GAUSS (A,RESULT)
      000       C
      000             DO 35 I=1,8
      000          35 FEET(I)=RESULT(I)*3.28
      000             WRITE(6,200) TCYC
      000             DO 40 ID=1,4
      000          40 WRITE(6,300) T(ID), TIDH(ID)
      000       C   WRITE OUT THE CALCULATED COEFFICIENTS
      000             WRITE(6,400) RESULT
      000             WRITE(6,500)
      000       C   CALCULATE TIDE HEIGHTS FOR 10 DEGREE INTERVALS THROUGH A FULL TIDE CYCLE
      000             DO 50 IC=1,36
      000             ANGLE=FLOAT(10*IC)
      000             BANGLE=ANGLE*2.*3.14159/360.
      000             VALUE=0.5*RESULT(1)+COS(BANGLE)*RESULT(2)+COS(2.*BANGLE)*RESULT(3)
      000            1      +COS(3.*BANGLE)*RESULT(4)+SIN(BANGLE)*RESULT(5)+SIN(2.*
      000            2      BANGLE)*RESULT(6)+SIN(3.*BANGLE)*RESULT(7)+SIN(4.*BANGLE)*
      000            3      RESULT(8)
      000             ATIME=(ANGLE/360.)*TCYC
      000         50  WRITE(6,600) ANGLE,ATIME,VALUE
      000             WRITE(6,601)
      000             GO TO 293
      000        291  CONTINUE
      000             WRITE(6,602)
      000        602  FORMAT(2X,'ERROR IN NAMELIST---NO FUNCTION GENERATED')
      000             GO TO 293
      000        292  CONTINUE
      000             WRITE(6,603)
      000        603  FORMAT(2X,'END OF FILE ENCOUNTERED IN READING DATA---NO FUNCTION G
      000            1ENERATED')
      000        293  CONTINUE
      000             RETURN
      000        320  FORMAT(20A4)
      000        330  FORMAT(1H ,20A4)
      000        200  FORMAT(2X,'TIDAL CYCLE LASTS',F7.2,1X,'HOURS',///,1X,
      000            1'INPUT STAGE TIME PAIRS',/,6X,'HOURS',5X,'METERS')
      000        400  FORMAT(1H0,'COEFFICIENTS FOR AN EQUATION OF FORM',6X,'F(X) = 0.5*A
      000            11 + A2*COS(THETA) + A3*COS(2*THETA)',/,45X,' + A4*COS(3*THETA) + A
      000            25*SIN(THETA) + A6*SIN(2*THETA)',/,45X,' + A7*SIN(3*THETA) + A8*SIN
      000            3(4*THETA),',//,40X,'WHERE F(X) HAS UNITS OF METERS, ARE AS FOLLOWS
      000            4',/,5X,'A1 = ',F8.3,/,5X,'A2 = ',F8.3,/,5X,'A3 = ',F8.3,/,5X,
      000            5'A4 = ',F8.3,/,5X,'A5 = ',F8.3,/,5X,'A6 = ',F8.3,/,5X,
      000            6'A7 = ',F8.3,/,5X,'A8 = ',F8.3)
      000        500  FORMAT(48H1FUNCTION VALUES LISTED FOR 10 DEGREE INCREMENTS,//,
      000            19X,'DEGREES',13X,'TIME(HRS)',5X,'HEIGHT(METERS)')
      000        600  FORMAT(1H ,5X,F12.2,2(5X,F12.4))
      000        601  FORMAT(1H1)
      000        300  FORMAT(4(1H ,2X,2F10.2))
      000              END

END ELT.
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```
 ******  FIND  ******

@ELT,L HMAINT.FIND


000001       000            SUBROUTINE FIND(ILAST,NJP,DUM,NJW,HP,NJ)
000002       000     C       THIS ROUTINE IS CALLED BY HYDPLT
000003       000            COMMON /TAPES/N5,N6,N20,N22,N24
000004       000            DIMENSION DUM(600),NJW(20),HP(20,200)
000005       000            READ (N24) (DUM(I),I=1,NJ)
000006       000            DO 100 I=1,NJP
000007       000            NP=NJW(I)
000008       000            HP(I,ILAST)=DUM(NP)
000009       000     100    CONTINUE
000010       000            RETURN
000011       000            END

END ELT.


@HDG,P  ******  GENFUN  ******
```

```
****** GENFUN ******

*ELT,L HMAINT.GENFUN

000        SUBROUTINE GENFUN (Z1,Z2,IY,IX,Z3)
000   C
000   C    ************** BATTELLE NORTHWEST 11/9/71                   *************
000   C    *******************************************************************************
000   C     THIS ROUTINE IS CALLED BY HYDCAL
000   C
000   C    ************** ASSIGN THE COMMON  DATA                      *************
000        COMMON /TAPES/N5,N6,N20,N22,N24
000        COMMON/PARAMS/IZ5,IZ6,IZ9,IZ12,IZ13
000   C
000   C    ************** CONTROL AND TITLE INFORMATION                *************
000        COMMON /PRINT/ NJ,NC,NTCYC,NOCYC,DELTQ,PERIOD,ALPHA(30),
000       1DEP(70),NQSWRT
000        COMMON/QUAL/NCHAN(70,6),AS(70),LEN(100),NJUNC(100,2)
000        COMMON/QIN/QINT,DELT,WIND,WDIR,NJSW,NJGW,NHCYC,NT,ICYC,NCYC,W,
000       1NEXIT,JSW(20),JGW(20),A0(3,20,10)
000   C
000   C    ************** JUNCTION INFORMATION                         *************
000   C
000        COMMON/HSO/H(70),HN(70),HT(70),HBAR(70),HAVE(70),
000       1IPOINT(70,6),VOL(70),X(70),Y(70),QIN(70),QOU(70),
000       2QINST(20),QINBAR(70),QOUBAR(70)
000   C
000   C    ************** CHANNEL INFORMATION                          *************
000   C
000        COMMON/B72/B(100),R(100),A(100),AT(100),AK(100),Q(100),QBAR(100),
000       1QAVE(100),V(100),VT(100),VBAR(100),FWIND(100),NTEMP(6),
000       2NCLOS(100)
000   C
000        REAL LEN
000   C    **************                 END                          *************
000   C    *******************************************************************************
000   C
000   C
000        IF (IY.EQ.2) GO TO 200
000   C
000   C    **************  CONTROLLED NODE FUNCTIONS DESIRED           *************
000        IJK=JGW(IX)
000        GO TO (100,120,130,170,140,140), IJK
000   C
000   C    **************   WIER FORMULA DESIRED                       *************
000   100  CONTINUE
000        Z2M=0.
000        CON=Z3/AS(IX)
000        DHLM=0.
000        DO 110 ICT=1,12
000        CM=CON*10.744
000        DHM=(Z2M+DHLM)/2.
000        DHLM=Z2M
000        Z2M=-CM*Z1/35.314
000        H2M=(H(IX)/3.28)+DHM/2.-A0(1,IX,2)
000        IF (H2M .LE. 0) GO TO 110
000        Z2M=CM*(-Z1/35.314-A0(1,IX,1)*(H2M)**A0(1,IX,3))
```

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```
 ******   GENFUN   ******

 000054      000           Z2=Z2M*3.28
 000055      000    110    CONTINUE                                                                  53
 000056      000           RETURN                                                                    54
 000057      000    C      **************                 END                   *************        55
 000058      000    C                                                                                56
 000059      000    C      **************   TIDAL CONTROLLED NODE               *************        57
 000060      000     120   Z2=0.5*A0(1,IX,1)+A0(1,IX,2)*COS(W*Z1)+A0(1,IX,3)*COS(2.*W*Z1)+
 000061      000          1A0(1,IX,4)*COS(3.*W*Z1)+A0(1,IX,5)*SIN(W*Z1)+A0(1,IX,6)*SIN(2.*W*Z
 000062      000          2Z1)+A0(1,IX,7)*SIN(3.*W*Z1)+A0(1,IX,8)*SIN(4.*W*Z1)
 000063      000           RETURN                                                                    61
 000064      000    C      **************                 END                   *************        62
 000065      000    C                                                                                63
 000066      000    C      **************           Q VS H NODE                  ************        64
 000067      000    130    TX=Z1                                                                     65
 000068      000           GO TO 150                                                                 66
 000069      000    C      **************              END                      *************        67
 000070      000    C      **************       HVS T AND Q VS T NODES          *************        68
 000071      000    140    CONTINUE                                                                  69
 000072      000           TX=Z1/3600.                                                               70
 000073      000    150    I1=1                                                                      71
 000074      000           I2=IX                                                                     72
 000075      000           IRETUR=1                                                                  73
 000076      000           GO TO 220                                                                 74
 000077      000    160    CONTINUE                                                                  75
 000078      000           Z2=ZZ                                                                     76
 000079      000           RETURN                                                                    77
 000080      000    C      **************                 END                   *************        78
 000081      000    C                                                                                79
 000082      000    C                                                                                80
 000083      000    C      **************   THIS IS THE H VS T AND Q VS T NODE  *************        81
 000084      000    170    CONTINUE                                                                  82
 000085      000           TX=Z3/3600.                                                               83
 000086      000           I1=1                                                                      84
 000087      000           I2=IX                                                                     85
 000088      000           IRETUR=2                                                                  86
 000089      000           GO TO 220                                                                 87
 000090      000    180    CONTINUE                                                                  88
 000091      000           Z2=ZZ                                                                     89
 000092      000           I1=2                                                                      90
 000093      000           IRETUR=3                                                                  91
 000094      000           GO TO 220                                                                 92
 000095      000    190    CONTINUE                                                                  93
 000096      000           Z1=ZZ                                                                     94
 000097      000           RETURN                                                                    95
 000098      000    C      **************                 END                   *************        96
 000099      000    C                                                                                97
 000100      000    C                                                                                98
 000101      000    C      **************   GENERATE THE HYDROGRAPH OUTPUTS     *************        99
 000102      000    200    CONTINUE                                                                 100
 000103      000           TX=Z1/3600.                                                              101
 000104      000           I1=3                                                                     102
 000105      000           I2=IX                                                                    103
 000106      000           IRETUR=4                                                                 104
 000107      000           GO TO 220                                                                105
 000108      000    210    CONTINUE                                                                 106
 000109      000           Z2=ZZ                                                                    107
 000110      000           RETURN                                                                   108
```

```
****** GENFUN ******

000111      000   C     **************              END                 *************    109
000112      000   C                                                                      110
000113      000   C                                                                      111
000114      000   C     ************** GENERATE  THE FUNCTION           *************    112
000115      000   220   CONTINUE                                                         113
000116      000         ZZ=A0(I1,I2,1)+A0(I1,I2,2)*TX+A0(I1,I2,3)*TX**2+A0(I1,I2,4)*TX**3+  114
000117      000        1A0(I1,I2,5)*TX**4+A0(I1,I2,6)*TX**5+A0(I1,I2,7)*TX**6+A0(I1,I2,8)*  115
000118      000        2TX**7+A0(I1,I2,9)*TX**8+A0(I1,I2,10)*TX**9                       116
000119      000         GO TO (160,180,190,210), IRETUR                                  117
000120      000   C     **************                END               *************    118
000121      000   C                                                                      119
000122      000         END

END ELT.

@HDG,P ****** HYDCAL ******
```

```
****** HYDCAL ******

@ELT,L HMAINT,HYDCAL

      SUBROUTINE HYDCAL
C      THIS ROUTINE IS CALLED BY HMAINV (OR HMAINT)
C      AND CALLS GENFUN
C                              BATTELLE NORTHWEST 11/9/71
C
C
C                              ASSIGN THE COMMON DATA
      COMMON /TAPES/N5,N6,N20,N22,N24
      COMMON/PARAMS/IZ5,IZ6,IZ9,IZ12,IZ13
C
C                              CONTROL AND TITLE INFORMATION
      COMMON /PRINT/ NJ,NC,NTCYC,NQCYC,DELTQ,PERIOD,ALPHA(30),
     1DEP(70),NQSWRT
      COMMON/QUAL/NCHAN(70,6),AS(70),LEN(100),NJUNC(100,2)
      COMMON/QIN/QINT,DELT,WIND,WDIR,NJSW,NJGW,NHCYC,NT,ICYC,NCYC,W,
     1NEXIT,JSW(20),JGW(20),A0(3,20,10)
C
C
C                              JUNCTION INFORMATION

      COMMON/H50/H(70),HN(70),HT(70),HBAR(70),HAVE(70),
     1IPOINT(70,6),VOL(70),X(70),Y(70),QIN(70),QOU(70),
     2QINST(20),QINBAR(70),QOUBAR(70)
C
C
C                              CHANNEL INFORMATION

      COMMON/B72/B(100),R(100),A(100),AT(100),AK(100),Q(100),QBAR(100),
     1QAVE(100),V(100),VT(100),VBAR(100),FWIND(100),NTEMP(6),
     2NCLOS(100)
      COMMON/NTR/NTRIB,TRBDEP(50),ITRIB(50,2)
C
      REAL LEN
      REAL LAM
      DIMENSION ARRAY(33)
      DIMENSION RSAV(100)
C                                        END
C
C
      DATA ASTERK/4H****/
C
C
C
C                              INPUT AND PRINT THE INPUT HYDRAULIC DATA
  100 CONTINUE
      READ (N20,1100) ARRAY
      IF (ARRAY(1).EQ.ASTERK) GO TO 110
      WRITE (N6,1100) ARRAY
      GO TO 100
  110 CONTINUE
      READ (N20) NTCYC,PERIOD,QINT,DELT,WIND,WDIR,NQSWRT,NJSW,NJGW
     1,(JSW(L),QINST(L),((A0(I,L,N),I=1,3),N=1,10),L=1,IZ12),(JGW(L),L=1
     2,IZ13),(ALPHA(I),I=1,30),NQCYC,NHCYC,NT,DELTQ,ICYC,NCYC,NEXIT,NJ,N
     3C,((NCHAN(I,II),IPOINT(I,II),II=1,IZ6),H(I),HN(I),HT(I),HBAR(I),HA
     4VE(I),AS(I),VOL(I),X(I),Y(I),DEP(I),QIN(I),QOU(I),QINBAR(I),QOUBAR
```

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```
****** HYDCAL ******

000        5(I),I=1,NJ),((NJUNC(N,L),L=1,2),LEN(N),B(N),R(N),A(N),AT(N),AK(N),
000        6Q(N),QBAR(N),QAVE(N),V(N),VT(N),VBAR(N),FWIND(N),NCLOS(N),N=1,NC),
000        7 EVAP,NTRIB,(TRBDEP(I),ITRIB(I,1),ITRIB(I,2),I=1,50),HYDEND
000   C   *** HYDEND IS A SPECIAL CASE - EPA PESTICIDE STUDY ***
000   C                                  END
000   C
000   C
000   C                         WRITE OUT HYDRAULIC DATA TO QUALITY TAPE
000         REWIND N22
000         WRITE (N22) (ALPHA(I),I=1,30),NJ,NC,NQCYC,DELTQ,NTCYC,NQSWRT,NJGW,
000        1EVAP,((NCHAN(J,K),K=1,IZ6),DEP(J),AS(J),J=1,NJ),(LEN(N),(NJUNC(N,K
000        2),K=1,2),N=1,NC),PERIOD,(JGW(I),I=1,NJGW)
000         WRITE (N22) ((IPOINT(J,K),K=1,IZ6),J=1,NJ)
000   C                                  END
000   C
000   C                         INITIALIZATION
000         NJGW1=NJGW+1
000         DELT2=DELT/2.0
000         W=6.2832/(3600.*PERIOD)
000         T=0.0
000         TIME=0.
000   C                                  END
000   C
000   C      THIS LOOP CALCULATES THE CONTROLLED NODE INITIAL CONDITIONS
000         DO 180 J=1,NJGW
000         IJK=JGW(J)
000         GO TO (180,120,130,140,150,160), IJK
000   C     WIER RELATIONS  REQUIRE NO CALCULATION AT THIS POINT
000   C     1801
000   C     TIDAL CONTROL STAGE
000   C
000   C      USE GENFUN TO CALCULATE INITIAL VALUES
000   120   CALL GENFUN (T,H(J),1,J,T)
000   C
000         Q(J)=0.
000         GO TO 170
000   C     DAM IS OPERATED VIA A Q VS H CURVE
000   C
000   C      USE GENFUN TO CALCULATE INITIAL VALUES
000   130   CALL GENFUN (H(J),Q(J),1,J,TIME)
000   C
000         GO TO 170
000   C     DAM WHOSE HEAD AND OUTFLOW ARE KNOWN FUNCTIONS OF TIME
000   C
000   C      USE GENFUN TO CALCULATE INITIAL VALUES
000   140   CALL GENFUN (H(J),Q(J),1,J,TIME)
000   C
000         GO TO 170
000   C     DAM WHOSE HEAD IS A KNOWN FUNCTION OF TIME AND WHOSE OUTFLOW IS
000   C     DETERMINED FROM A MASS BALANCE
000   C
000   C      USE GENFUN TO CALCULATE INITIAL VALUES
000   150   CALL GENFUN (TIME,H(J),1,J,TIME)
000   C
000         Q(J)=0.
000         GO TO 170
000   C     DAM WHOSE OUTFLOW IS A KNOWN FUNCTION OF TIME AND WHOSE HEAD IS
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```
000111       000   C     DETERMINED FROM A MASS BALANCE                                         98
000112       000   C
000113       000   C      USE GENFUN TO CALCULATE INITIAL VALUES
000114       000   160   CALL GENFUN (TIME,Q(J),1,J,TIME)                                       99
000115       000   C
000116       000   170   V(J)=0.                                                               100
000117       000   180   CONTINUE                                                              101
000118       000   C                                   END
000119       000   C                                                                           103
000120       000   C      COMPUTE THE CHANNEL CONSTANTS
000121       000         DO 241 N=1,NC
000122       000   241   RSAV(N)=-R(N)
000123       000         DO 240 N=1,NC                                                         105
000124       000   C      CHECK TO BE SURE THAT IF THERE IS NO NODE NUMBER ASSIGNED TO
000125       000   C       THE END OF A GIVEN CHANNEL THAT THE CHANNEL IS ADJACENT TO
000126       000   C       A CONTROLLED NODE
000127       000         IF ((NJUNC(N,1).EQ.0).AND.(N.LE.NJGW)) GO TO 190                      106
000128       000         IF (NJUNC(N,1).LE.0) GO TO 240                                        107
000129       000   190   CONTINUE                                                              108
000130       000   C      MODIFY MANNING'S COEFFICIENT
000131       000         AK(N)=32.1739*AK(N)**2/2.208196                                       109
000132       000         NL=NJUNC(N,1)                                                         110
000133       000         NH=NJUNC(N,2)                                                         111
000134       000         IF (N.LE.NJGW) NL=NH                                                  112
000135       000   C      COMPUTE AVG RIVER DEPTH IN CHANNEL USING AVG HEAD (FROM NODES)
000136       000   C       AND RIVER BOTTOM ELEVATION (NOTE THAT SIGN CONVENTION
000137       000   C       MAKES BOTTOM ELEVATION NEGATIVE)
000138       000         R(N)=R(N)+(H(NL)+H(NH))/2.                                            113
000139       000   C     ********* ARE THERE ANY TIDAL FLATS *******************************
000140       000         IF (NTRIB.LE.0) GO TO 220                                             114
000141       000         DO 200 I=1,NTRIB                                                      115
000142       000         IF (N.EQ.ITRIB(I,1)) GO TO 210                                        116
000143       000   200   CONTINUE                                                              117
000144       000         GO TO 220                                                             118
000145       000   210   IJN=ITRIB(I,2)                                                        119
000146       000         IF (IJN.EQ.NL) IHJN=NH                                                120
000147       000         IF (IJN.EQ.NH) IHJN=NL                                                121
000148       000   C      RIVER DEPTH IS THE DIFFERENCE BETWEEN HEAD AND BOTTOM
000149       000   C       ELEVATION (NOTE THAT DEP IS NEGATIVE)
000150       000         R(N)=H(IJN)+TRBDEP(I)
000151       000         IF (H(IHJN).LT.H(IJN)) GO TO 220                                      123
000152       000   C      COMPUTE AVG RIVER DEPTH (NOTE SIGN CONVENTION)
000153       000         R(N)=(H(IHJN)+H(IJN))/2.+TRBDEP(I)
000154       000   220   CONTINUE                                                              125
000155       000   C      AREA = WIDTH*DEPTH
000156       000         A(N)=B(N)*R(N)                                                        126
000157       000         IF (WIND.LE.0.0) GO TO 230                                            127
000158       000   C      CALCULATE WIND FORCE
000159       000         FWIND(N)=-WIND**2*COS(WDIR/57.-ATAN2((X(NH)-X(NL)),(Y(NH)-Y(NL))))    128
000160       000        1*8.64E-6                                                              129
000161       000   230   CONTINUE                                                              130
000162       000         AT(N)=A(N)                                                            131
000163       000         QAVE(N)=0.                                                            132
000164       000   240   CONTINUE                                                              133
000165       000   C                                   END
000166       000   C                                                                           135
000167       000   C     **************    COMPUTE THE NODAL VOLUMES        *************    136
```

```
000          DO 260 J=1,NJ
000          VOL(J)=0.
000          IF (AS(J).EQ.0.) GO TO 260
000          VOL(J)=(H(J)+DEP(J))*AS(J)
000    260   CONTINUE
000    C     **************               END                    *************
000    C
000    C
000    C     ************* START OF OUTER DO LOOP *****************************
000    C     *****************************************************************
000    C     NT=THE DAILY CYCLE NUMBER
000    C     NTCYC=THE NUMBER OF DAILY CYCLES TO BE SIMULATED
000    C     *****************************************************************
000    C     *****************************************************************
000    C
000    C
000          DO 910 NT=1,NTCYC
000          HOUR=0.0
000    C
000    C
000    C     ************* START OF THE 2ND OF THREE NESTED DO LOOPS **********
000    C     *****************************************************************
000    C     NQ=THE QUALITY CYCLE NUMBER
000    C     NQCYC=THE NUMBER OF QUALITY CYCLES PER DAILY CYCLE
000    C     *****************************************************************
000    C     *****************************************************************
000    C
000    C
000          DO 900 NQ=1,NQCYC
000    C
000    C     ************** INITIALIZE THE OUTPUT ARRAYS FOR THE SWQUAL ROUTINE
000          DO 270 N=1,NC
000          VBAR(N)=0.
000    270   QBAR(N)=0.
000          DO 280 J=1,NJ
000          HBAR(J)=0.
000          QINBAR(J)=0.
000          QOUBAR(J)=0.
000    280   CONTINUE
000    C     **************               END                    *************
000    C
000    C
000    C     ************* START OF THE THIRD OF THREE  NESTED DO LOOPS *******
000    C     *****************************************************************
000    C     NHH=THE HYDRAULIC CYCLE COUNTER
000    C     NHCYC=THE NUMBER OF HYDRAULIC CYCLES PER QUALITY CYCLE
000    C     *****************************************************************
000    C     *****************************************************************
000    C
000    C
000          DO 860 NHH=1,NHCYC
000    C     *****************************************************************
000    C     TIME IS THE TIMING VARIABLE THAT BEGINS AFTER THE FLOW PATTERNS
000    C     HAVE REACHED EQUILIBRIUM
000    C     *****************************************************************
000          IF (NT.LT.NQSWRT) GO TO 300
000          TIME=TIME+DELT
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```
******   HYDCAL   ******
                                                                                  203
          000          TIM2=TIME-DELT2                                            204
          000    C                                                                205
          000    C     *********** HYDROGRAPH INPUTS ******************************** 206
          000          IF (NJSW.EQ.0) GO TO 300                                   207
          000          DO 290 L=1,NJSW                                            208
          000          J=JSW(L)
          000    C
          000    C  ++++++ USE SUBROUTINE GENFUN TO GENERATE FUNCTIONAL VALUES ++++++  209
          000          CALL GENFUN (TIME,QIN(J),2,L,TIME)
          000    C   *** SPECIAL CASE - EPA PESTICIDE STUDY
          000    C      THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
          000          IF (TIME.GT.HYDEND.AND.HYDEND.NE. 0.0) QIN(J) = 0.0          PEST
          000          IF(QIN(J).LT.0.0) QIN(J) = 0.0
          000    C                                                                210
          000    290   QIN(J)=QINST(L)+QIN(J)                     *************   211
          000    C     *************           END                                212
          000    C                                                                213
          000    C                                                *************   214
          000    C     *************            INITIALIZATION                    215
          000    300   CONTINUE                                                   216
          000          T2=T+DELT2                                                 217
          000          T=T+DELT                                                   218
          000          DO 310 N=1,NC                                              219
          000          NCLOS(N)=0                                                 220
          000          DO 310 M=1,2                                               221
          000    310   NJUNC(N,M)=IABS(NJUNC(N,M))                                222
          000          DO 320 J=1,NJ                                              223
          000          AS(J)=ABS(AS(J))                                           224
          000          DO 320 K=1,IZ6                                             225
          000    320   NCHAN(J,K)=IABS(NCHAN(J,K))                                226
          000          NTIMS=0                                    *************   227
          000    C     *************           END                                228
          000    C                                                                229
          000    C     ************* COMPUTATION OF VELOCITIES  AT 1/2 DELT   **********
          000    C     ************* AND FLOWS AT 1/4 DELT         ************   230
          000    C                                                                231
          000    330   CONTINUE                                                   232
          000          NDRY=0                                                     233
          000          NTIMS=NTIMS+1
          000    C  ++++++ THE FIRST NJGW CHANNELS ARE CONNECTED TO THE NJGW CONTROLLED
          000    C  ++++++      NODES AND MUST BE TREATED SEPARATELY.  CHECK THE REST
          000    C  ++++++      OF THE CHANNELS TO SEE IF THEY HAVE DRIED UP, AND, IF THEY
          000    C  ++++++      HAVE, SKIP THE CALCULATIONS. ++++++                 234
          000          DO 380 N=NJGW1,NC                                          235
          000          IF (NJUNC(N,1).LE.0) GO TO 380
          000    C  ++++++ DRY CHANNEL CHECK (DRY IMPLYING THAT DEPTH IS LESS THAN 0.01
          000    C  ++++++      METERS OR 0.033 FEET) ++++++
          000          IF(R(N).GE.0.001)  GO TO 340                               238
          000          VT(N)=0.0                                                  239
          000          Q(N)=0.0                                                   240
          000          GO TO 380                                                  241
          000    340   CONTINUE                                                   242
          000          NL=NJUNC(N,1)                                              243
          000          NH=NJUNC(N,2)
          000    C  ++++++ DELTH = DIFFERENCE BETWEEN HEADS AT THE NODES AT EACH END OF THE
          000    C  ++++++       CHANNEL (BEGINNING OF TIMESTEP) ++++++
          000          DELTH=H(NH)-H(NL)
          000          DELTZ=DEP(NL)-DEP(NH)
```

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```
****** HYDCAL ******
000         DELH=0.5*(H(NH)-HT(NH)+H(NL)-HT(NL))
000         DELTY=DELTH-DELTZ
000  C  ****** ARE THERE ANY TRIBUTARY CHANNELS? ******
000         IF (NTRIB.LE.0) GO TO 370                                    245
000         DO 350 IL=1,NTRIB                                            246
000  C  ****** IS CHANNEL N A TRIBUTARY CHANNEL? ******
000         IF (N.EQ.ITRIB(IL,1)) GO TO 360                              247
000  350    CONTINUE                                                     248
000         GO TO 370                                                    249
000  C      ****** IJN=NUMBER OF THE TIDE FLAT NODE **************************
000  360    IJN=ITRIB(IL,2)                                              250
000         IF (IJN.EQ.NL) IHJN=NH                                       251
000         IF (IJN.EQ.NH) IHJN=NL                                       252
000         DELTZ=2.*(DEP(IJN)-TRBDEP(IL))
000         IF(IHJN.LT.IJN) DELTZ=-DELTZ
000         DELTY=DELTH-DELTZ
000         IF(H (IJN).GT.H (IHJN))  DELH=H (IJN)-HT (IJN)
000         IF(H (IJN).GT.H (IHJN))  DELTY=0.0
000         IF(H(IJN).GT.H(IHJN))  R(N)=H(IJN )+TRBDEP(IL)
000         IF(H(IJN).GT.H(IHJN))  A(N)=R(N)*B(N)
000  370    CONTINUE                                                     256
000  C
000         TEMP=AK(N)/(R(N)**1.3333)
000         TEMP=TEMP*DELT2
000         HCHAN=(H(NH)+H(NL))/2.
000  C
000         DELV1= V(N)/R(N)*(DELH/DELT2+V(N)*DELTY/LEN(N))
000         V2=V(N)+DELT2*DELV1
000  C
000         DELV2=-32.1739*DELTZ/LEN(N)
000         V2=V2+DELT2*DELV2
000  C
000         DELV4=-32.1739*(DELTH-DELTZ)/LEN(N)
000         V2=V2+DELT2*DELV4
000  C
000         DELV3=0.5*((1./TEMP+2.*ABS(V2))-SQRT((1./TEMP+ABS(2.*V2))**2-4.*V2
000        1**2))
000         DELV3=-SIGN(DELV3,V2)
000         VT(N)=V2+DELV3
000  C
000  C
000         Q(N)=VT(N)*A(N)                                              265
000  380    CONTINUE                                                     266
000  C      **************            END                **************  267
000  C                                                                   268
000  C      ************* CONTROLLED NODE CALCULATIONS ********************** 269
000  C      ************** FLOW AT 1/4 DELT AND HEAD AT 1/2 DELT ************* 270
000  C      ***************************************************************** 271
000         DO 470 J=1,NJGW                                              272
000  C
000  C  ****** CALCULATE NET FLOW OUT OF NODE (SUMQ) DUE TO FLOWS
000  C  ******        CALCULATED IN ADJACENT CHANNELS ******
000         SUMQ=0.                                                      273
000         DO 400 K=1,IZ6                                               274
000         IF (NCHAN(J,K).EQ.J) GO TO 400                               275
000         IF (NCHAN(J,K).LE.0) GO TO 400                               276
000         N=NCHAN(J,K)                                                 277
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******   HYDCAL   ******

000339      000              IF (J.NE.NJUNC(N,1)) GO TO 390                                     278
000340      000              SUMQ=SUMQ+Q(N)                                                     279
000341      000              GO TO 400                                                          280
000342      000      390     SUMQ=SUMQ-Q(N)                                                     281
000343      000      400     CONTINUE                                                           282
000344      000      C
000345      000      C  ****** NET FLOW OUT ******
000346      000              SUMQ=SUMQ+QOU(J)-QIN(J)+EVAP*AS(J)                                 283
000347      000              IJK=JGW(J)                                                         284
000348      000      C  ****** WHAT TYPE OF CONTROLLED NODE? ******
000349      000              GO TO (410,420,430,440,450,460), IJK                               285
000350      000      C       WEIR RELATIONSHIP                                                  286
000351      000      C
000352      000      C  ****** USE SUBROUTINE GENFUN TO GENERATE FUNCTIONAL VALUES ******
000353      000      410     CALL GENFUN (SUMQ,DELHH,1,J,DELT2)                                 287
000354      000      C
000355      000              Q(J)=-DELHH*AS(J)/DELT2-SUMQ                                       288
000356      000              IF (Q(J).LT.0.) Q(J)=0.                                            289
000357      000              VT(J)=0.                                                           290
000358      000      C  ****** CHANGE HEAD TO ACCOMODATE NET FLOW ******
000359      000              HT(J)=H(J)+DELHH                                                   291
000360      000              GO TO 470                                                          292
000361      000      C       TIDAL CONTROL STAGE                                                293
000362      000      C
000363      000      C  ****** USE SUBROUTINE GENFUN TO GENERATE FUNCTIONAL VALUES ******
000364      000      420     CALL GENFUN (T2,HT(J),1,J,T2)                                      294
000365      000      C
000366      000              Q(J)=-SUMQ-(HT(J)-H(J))*AS(J)/DELT2                                295
000367      000              VT(J)=0.                                                           296
000368      000              GO TO 470                                                          297
000369      000      C       DAM IS OPERATED ACCORDING TO A Q VS H OPERATION POLICY             298
000370      000      C
000371      000      C  ****** USE SUBROUTINE GENFUN TO GENERATE FUNCTIONAL VALUES ******
000372      000      430     CALL GENFUN (H(J),Q(J),1,J,TIM2)                                   299
000373      000      C
000374      000      C  ****** NET FLOW *****
000375      000              SUMQ=SUMQ+Q(J)                                                     300
000376      000      C  ****** CHANGE HEAD TO ACCOMODATE NET FLOW ******
000377      000              HT(J)=H(J)-DELT2*SUMQ/AS(J)                                        301
000378      000              VT(J)=0.                                                           302
000379      000              GO TO 470                                                          303
000380      000      C       DAM WHOSE HEAD AND OUTFLOW ARE KNOWN FUNCTIONS OF TIME             304
000381      000      C
000382      000      C  ****** USE SUBROUTINE GENFUN TO GENERATE FUNCTIONAL VALUES ******
000383      000      440     CALL GENFUN (HT(J),Q(J),1,J,TIM2)                                  305
000384      000      C
000385      000              VT(J)=0.                                                           306
000386      000              GO TO 470                                                          307
000387      000      C       DAM WHOSE HEAD IS A KNOWN FUNCTION OF TIME AND WHOSE OUTPUT IS     308
000388      000      C       DETERMINED FROM A MASS BALANCE                                     309
000389      000      C
000390      000      C  ****** USE SUBROUTINE GENFUN TO GENERATE FUNCTIONAL VALUES ******
000391      000      450     CALL GENFUN (TIM2,HT(J),1,J,TIM2)                                  310
000392      000      C
000393      000              Q(J)=-SUMQ-(HT(J)-H(J))*AS(J)/DELT2                                311
000394      000              IF (Q(J).LT.0.) Q(J)=0.                                            312
000395      000              VT(J)=0.                                                           313
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```
000         GO TO 470
000   C     DAM WHOSE OUTFLOW IS A KNOW FUNCTION OF TIME AND WHOSE HEAD IS
000   C     DETERMINED FROM A MASS BALANCE
000   C
000   C  ****** USE SUBROUTINE GENFUN TO GENERATE FUNCTIONAL VALUES ******
000   460   CALL GENFUN (TIM2,Q(J),1,J,TIM2)
000   C
000   C  ****** NET FLOW *****
000         SUMQ=SUMQ+Q(J)
000   C  ****** CHANGE HEAD TO ACCOMODATE NET FLOW ******
000         HT(J)=H(J)-DELT2*SUMQ/AS(J)
000         VT(J)=0.
000   470   CONTINUE
000   C     ***************                  END                   *************
000   C     *****************************************************************
000   C
000   C     ************* REGULAR NODES STAGE AT 1/2 DELT          *************
000         DO 510 J=NJGW1,NJ
000   C
000   C  ****** CALCULATE NET FLOW OUT OF NODE (SUMQ) DUE TO FLOWS
000   C  ******        CALCULATED IN ADJACENT CHANNELS ******
000         SUMQ=0.
000         DO 490 K=1,IZ6
000         IF (NCHAN(J,K).LE.0) GO TO 490
000         N=NCHAN(J,K)
000         IF (J.NE.NJUNC(N,1)) GO TO 480
000         SUMQ=SUMQ+Q(N)
000         GO TO 490
000   480   SUMQ=SUMQ-Q(N)
000   490   CONTINUE
000   C
000         IF (AS(J).LE.0.) GO TO 510
000   C  ****** NET FLOW OUT ******
000         SUMQ=SUMQ+QOU(J)-QIN(J)+EVAP*AS(J)
000   C  ****** CHANGE HEAD TO ACCOMODATE NET FLOW ******
000         HT(J)=H(J)-DELT2*SUMQ/AS(J)
000   C  ****** IS HEAD GREATER THAN BOTTOM ELEVATION (IS THERE WATER PRESENT)? +
000         IF (HT(J)+DEP(J).GT.0.) GO TO 510
000   C  ****** NODE IS DRY, SO SET HEAD EQUAL TO BOTTOM ELEVATION
000   C  ******        (BUT CHANGE SIGN) ******
000         HT(J)=-DEP(J)
000         VOL(J)=0.
000         AS(J)=-AS(J)
000         DO 500 K=1,IZ6
000         NX=NCHAN(J,K)
000         IF (NX.LE.0) GO TO 500
000         IF (NX.LE.NJGW) GO TO 500
000   C  ****** MARK AS A DRY CHANNEL ******
000         NCLOS(NX)=1
000   500   CONTINUE
000   C  ****** MARK AS A DRY NODE ******
000         NDRY=NDRY+1
000   510   CONTINUE
000         IF (NDRY.EQ.0) GO TO 560
000         IF (NTIMS.GT.2) GO TO 560
000         DO 550 N=NJGW1,NC
000         IF (NJUNC(N,1).LE.0) GO TO 550
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```
000         IF (NCLOS(N).NE.1) GO TO 550
000         Q(N)=0.
000         V(N)=0.
000         VT(N)=0.0
000         DO 540 I=1,2
000         II=NJUNC(N,I)
000         DO 520 J=1,IZ6
000         IF (NCHAN(II,J).EQ.N) GO TO 530
000   520   CONTINUE
000         GO TO 540
000   530   NCHAN(II,J)=-N
000   540   NJUNC(N,I)=-II
000   550   CONTINUE
000         GO TO 330
000   560   CONTINUE
000   C     ***************                END                        *************
000   C
000   C     *************** COMPUTATION OF CROSSECTIONAL AREA AND FLOW AT 1/2 D
000   C     *************** AND VELOCITIES AT THE FULL DELT           *************
000         DO 630 N=NJGW1,NC
000         IF (NJUNC(N,1).LE.0) GO TO 630
000         NL=NJUNC(N,1)
000         NH=NJUNC(N,2)
000   C  ++++++ HEAD INCREMENT = AVG OF THE CHANGE IN HEAD OVER ONE-HALF
000   C  ++++++      TIMESTEP AT THE TWO CHANNEL ENDS ++++++
000         DELH=0.5*(HT(NH)-H(NH)+HT(NL)-H(NL))
000         DELTH=HT(NH)-HT(NL)
000         DELTZ=DEP(NL)-DEP(NH)
000         DELTY=DELTH-DELTZ
000         RNT=R(N)+DELH
000         HCHAN=(HT(NH)+HT(NL))/2.
000         AT(N)=A(N)+B(N)*DELH
000   C     ********* ARE THERE ANY TIDAL FLATS *****************************
000         IF (NTRIB.LE.0) GO TO 590
000         DO 570 IL=1,NTRIB
000   C     ****** IS CHANNEL N A TIDE FLAT CHANNEL **************************
000         IF (N.EQ.ITRIB(IL,1)) GO TO 580
000   570   CONTINUE
000         GO TO 590
000   580   IJN=ITRIB(IL,2)
000         IF (IJN.EQ.NH) IHJN=NL
000         IF (IJN .EQ. NL) IHJN=NH
000         DELTZ=2.*(DEP(IJN)-TRBDEP(IL))
000         IF(IHJN.LT.IJN) DELTZ=-DELTZ
000         DELTY=DELTH-DELTZ
000         IF(HT(IJN).GT.HT(IHJN))  DELTY=0.0
000         IF(HT(IJN).GT.HT(IHJN))  DELH=HT(IJN)-H  (IJN)
000         RNT=HT(IJN)+TRBDEP(IL)
000         IF(HT(IJN).GT.HT(IHJN))  RNT=(HT(IHJN)+HT(IJN))/2.+TRBDEP(IL)
000         AT(N)=B(N)*RNT
000   590   CONTINUE
000   C     *************** DRY CHANNEL CHECK  (UNDER 0.1 FEET)   *************
000   C  ++++++ IF CHANNEL IS DRY, SET VELOCITY AND FLOW TO ZERO ++++++
000         IF(RNT.GT.0.001)  GO TO 600
000         V(N)=0.
000         Q(N)=0.
000         GO TO 610
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******   HYDCAL   ******

000510     000   600   CONTINUE
000511     000         TEMP=AK(N)/(RNT**1.3333)                                           399
000512     000         TEMP=TEMP*DELT
000513     000   C
000514     000         DELV1=(VT(N)/RNT)*(DELH/DELT2+VT(N)*DELTY/LEN(N))
000515     000         V(N)=V(N)+DELT*DELV1
000516     000   C
000517     000         DELV2=-32.1739*DELTZ/LEN(N)
000518     000         V(N)=V(N)+DELT*DELV2
000519     000   C
000520     000         DELV4=-32.1739*(DELTH-DELTZ)/LEN(N)
000521     000         V(N)=V(N)+DELT*DELV4
000522     000   C
000523     000         DELV3=0.5*((1./TEMP+2.*ABS(V(N)))-SQRT((1./TEMP+2.*ABS(V(N)))**2-
000524     000        14.*V(N)**2))
000525     000         DELV3=-SIGN(DELV3,V(N))
000526     000         V(N)=V(N)+DELV3
000527     000   C
000528     000   C
000529     000   C
000530     000   C  ++++++ CALCULATE FLOW BASED ON NEW VELOCITY (AVERAGE PREVIOUS
000531     000   C  ++++++       FLOW AND CURRENT VALUE ++++++
000532     000         Q(N)=0.5*(Q(N)+V(N)*AT(N))
000533     000   610   CONTINUE                                                           408
000534     000   C     *************** SUM THE CHANNEL FLOWS               *************  409
000535     000   C  ++++++ NT = DAILY CYCLE NUMBER ++++++                                 410
000536     000         IF (NT.LT.NQSWRT) GO TO 620
000537     000         QBAR(N)=QBAR(N)+Q(N)                                               411
000538     000         VBAR(N)=VBAR(N)+V(N)                                               412
000539     000   620   CONTINUE                                                           413
000540     000   C     *************** CHECK FOR EXCESSIVE VELOCITIES      *************  414
000541     000         RAN=R(N)/3.28                                                      415
000542     000         VAN=V(N)/3.28
000543     000         IF (ABS(VAN) .LT. 10.0) GO TO 630
000544     000         WRITE(N6,1110) NT,NQ,NHH,RAN,VAN,N
000545     000   630   CONTINUE
000546     000   C     ***************                  END                *************  418
000547     000   C                                                                        419
000548     000   C     ************* CONTROLLED NODE CALCULATIONS AT FULL TIME STEP *****  420
000549     000   C     *****************************************************************  421
000550     000         DO 740 J=1,NJGW                                                    422
000551     000   C                                                                        423
000552     000   C  ++++++ CALCULATE NET FLOW OUT OF NODE (SUMQ) DUE TO FLOWS
000553     000   C  ++++++       CALCULATED IN ADJACENT CHANNELS ++++++
000554     000         SUMQ=0.
000555     000         DO 650 K=1,IZ6                                                     424
000556     000         IF (NCHAN(J,K).EQ.J) GO TO 650                                     425
000557     000         IF (NCHAN(J,K).LE.0) GO TO 650                                     426
000558     000         N=NCHAN(J,K)                                                       427
000559     000         IF (J.NE.NJUNC(N,1)) GO TO 640                                     428
000560     000         SUMQ=SUMQ+Q(N)                                                     429
000561     000         GO TO 650                                                          430
000562     000   640   SUMQ=SUMQ-Q(N)                                                     431
000563     000   650   CONTINUE                                                           432
000564     000   C                                                                        433
000565     000   C  ++++++ NET FLOW OUT ++++++
000566     000         SUMQ=SUMQ+QOU(J)-QIN(J)+EVAP*AS(J)                                 434
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****** HYDCAL ******

000567      000              IJK=JGW(J)                                                      435
000568      000       C  ****** WHAT TYPE OF CONTROLLED NODE? ******
000569      000              GO TO (660,680,690,700,710,720), IJK                           436
000570      000       C      WEIR RELATIONSHIP                                               437
000571      000       C
000572      000       C  ****** USE GENFUN TO CALCULATE FUNCTIONAL VALUES ******
000573      000       660    CALL GENFUN (SUMQ,DELHH,1,J,DELT)                               438
000574      000       C
000575      000              Q(J)=-DELHH*AS(J)/DELT-SUMQ                                     439
000576      000              IF (Q(J).LT.0.) Q(J)=0.                                         440
000577      000              V(J)=0.                                                         441
000578      000       C  ****** CHANGE HEAD TO ACCOMMODATE NET FLOW ******
000579      000              HN(J)=H(J)+DELHH                                                442
000580      000       C  ****** CALCULATE VOLUME CHANGE ******
000581      000       670    DVOL=(HN(J)-H(J))*AS(J)                                         443
000582      000       C  ****** NEW VOLUME ******
000583      000              VOL(J)=VOL(J)+DVOL                                              444
000584      000              GO TO 730                                                       445
000585      000       C      TIDAL CONTROL STAGE                                             446
000586      000       C
000587      000       C  ****** USE GENFUN TO CALCULATE FUNCTIONAL VALUES ******
000588      000       680    CALL GENFUN (T,HN(J),1,J,T)                                     447
000589      000       C
000590      000              Q(J)=-SUMQ-(HN(J)-H(J))*AS(J)/DELT                              448
000591      000              V(J)=0.                                                         449
000592      000              GO TO 670                                                       450
000593      000       C      DAM OPERATED ACCORDING TO A Q VS H OPERATING POLICY             451
000594      000       C
000595      000       C  ****** USE GENFUN TO CALCULATE FUNCTIONAL VALUES ******
000596      000       690    CALL GENFUN (HT(J),QJ2,1,J,TIME)                                452
000597      000       C
000598      000              Q(J)=(Q(J)+QJ2)/2.                                              453
000599      000       C  ****** NET FLOW OUT ******
000600      000              SUMQ=SUMQ+Q(J)                                                  454
000601      000       C  ****** CHANGE HEAD TO ACCOMMODATE NET FLOW ******
000602      000              HN(J)=H(J)-DELT*SUMQ/AS(J)                                      455
000603      000              V(J)=0.                                                         456
000604      000              GO TO 670                                                       457
000605      000       C      DAM WHOSE HEAD AND OUTFLOW ARE KNOWN FUNCTIONS OF TIME          458
000606      000       C
000607      000       C  ****** USE GENFUN TO CALCULATE FUNCTIONAL VALUES ******
000608      000       700    CALL GENFUN (HN(J),QJ2,1,J,TIME)                                459
000609      000       C
000610      000              Q(J)=(Q(J)+QJ2)/2.                                              460
000611      000              V(J)=0.                                                         461
000612      000              GO TO 670                                                       462
000613      000       C      DAM WHOSE HEAD IS A KNOWN FUNCTION OF TIME AND WHOSE OUTFLOW    463
000614      000       C      IS DETERMINED FROM A MASS BALANCE                               464
000615      000       C
000616      000       C  ****** USE GENFUN TO CALCULATE FUNCTIONAL VALUES ******
000617      000       710    CALL GENFUN (TIME,HN(J),1,J,TIME)                               465
000618      000       C
000619      000              Q(J)=-SUMQ-(HN(J)-H(J))*AS(J)/DELT                              466
000620      000              IF (Q(J).LT.0.) Q(J)=0.                                         467
000621      000              V(J)=0.                                                         468
000622      000              GO TO 670                                                       469
000623      000       C      DAM WHOSE OUTFLOW IS A KNOWN FUNCTION OF TIME AND WHOSE HEAD IS 470
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C       COMPUTED FROM A MASS BALANCE
C
C  ++++++ USE GENFUN TO CALCULATE FUNCTIONAL VALUES ++++++
  720   CALL GENFUN (TIME,QJ2,1,J,TIME)
C
        Q(J)=(Q(J)+QJ2)/2.
C  ++++++ NET FLOW OUT ++++++
        SUMQ=SUMQ+Q(J)
C  ++++++ CHANGE HEAD TO ACCOMMODATE NET FLOW ++++++
        HN(J)=H(J)-DELT*SUMQ/AS(J)
        V(J)=0.
        GO TO 670
C
C       ************** SUM THE CHANNEL FLOWS FOR THE CONTROL NODES *******
  730   IF (NT.LT.NQSWRT) GO TO 740
        QBAR(J)=QBAR(J)+Q(J)
        VBAR(J)=VBAR(J)+V(J)
C       **************               END                    *************
C
  740   CONTINUE
C       **************               END                    *************
C       *****************************************************************
C
C       ************** COMPUTATION OF NODAL STAGE AND VOLUME AT FULL DELT
        DO 770 J=NJGW1,NJ
C
C  ++++++ CALCULATE NET FLOW OUT OF NODE (SUMQ) DUE TO FLOWS
C  ++++++      CALCULATED IN ADJACENT CHANNELS ++++++
        SUMQ=0.
        HN(J)=-DEP(J)
        IF (AS(J).LE.0.) GO TO 770
        DO 760 K=1,IZ6
        IF (NCHAN(J,K).LE.0) GO TO 760
        N=NCHAN(J,K)
        IF (J.NE.NJUNC(N,1)) GO TO 750
        SUMQ=SUMQ+Q(N)
        GO TO 760
  750   SUMQ=SUMQ-Q(N)
  760   CONTINUE
C
C  ++++++ NET FLOW OUT ++++++
        SUMQ=SUMQ+QOU(J)-QIN(J)+EVAP*AS(J)
C  ++++++ CHANGE HEAD BASED ON CALCULATED NET FLOW ++++++
        HN(J)=H(J)-DELT*SUMQ/AS(J)
        HT(J)=0.5*(HN(J)+H(J))
        VOL(J)=VOL(J)-DELT*SUMQ
  770   CONTINUE
C       **************               END                    *************
C
C       ************** SUM NODAL VOLUMES AND FLOWS          *************
        IF (NT.LT.NQSWRT) GO TO 790
        DO 780 J=1,NJ
        HBAR(J)=HBAR(J)+HN(J)
        QINBAR(J)=QINBAR(J)+QIN(J)
        QOUBAR(J)=QOUBAR(J)+QOU(J)
  780   CONTINUE
  790   CONTINUE
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BOTTOM OF
IMAGE AREA:
OUTSIDE
DIMENSION
FOR TABLES
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******   HYDCAL   ******
000681      000   C      **************               END                   *************   516
000682      000   C                                                                         517
000683      000   C      ************** CALCULATE THE HYDRAULIC RADIUS AND CHANNEL CROSSECT   518
000684      000   C      ************** AREA AT THE FULL DELT                *************   519
000685      000          DO 840 N=NJGW1,NC                                                  520
000686      000          IF (NJUNC(N,1).EQ.0) GO TO 840                                     521
000687      000          NL=IABS(NJUNC(N,1))                                                522
000688      000          NH=IABS(NJUNC(N,2))                                                523
000689      000   C  ++++++ CALCULATE HEAD INCREMENT AS THE AVERAGE OF THE CHANGE
000690      000   C  ++++++      IN HEAD AT EACH END OF THE CHANNEL OVER ONE-HALF TIMESTEP ++
000691      000          DELH=0.5*(HN(NH)-H(NH)+HN(NL)-H(NL))                               524
000692      000   C      ********* ARE THERE ANY TIDAL FLATS ********************************
000693      000          IF (NTRIB.LE.0) GO TO 830                                          525
000694      000          DO 800 IL=1,NTRIB                                                  526
000695      000   C      ****** IS CHANNEL N A TIDE FLAT CHANNEL ***************************
000696      000          IF (N.EQ.ITRIB(IL,1)) GO TO 810                                    527
000697      000   800    CONTINUE                                                           528
000698      000          GO TO 830                                                          529
000699      000   810    IJN=ITRIB(IL,2)                                                    530
000700      000          IF (IJN.EQ.NL) IHJN=NH                                             531
000701      000          IF (IJN.EQ.NH) IHJN=NL                                             532
000702      000          R(N)=HN(IJN)+TRBDEP(IL)
000703      000          IF(HN(IHJN).GT.HN(IJN)) R(N)=(HN(IHJN)+HN(IJN))/2.+TRBDEP(IL)
000704      000   C  ++++++ CALCULATE CROSS-SECTIONAL AREA BASED ON NEW RADIUS ++++++
000705      000          A(N)=B(N)*R(N)                                                     535
000706      000          GO TO 840                                                          536
000707      000   830    CONTINUE                                                           540
000708      000   C  ++++++ CALCULATE NEW RADIUS BY ADDING HEAD INCREMENT TO OLD VALUE ++++++
000709      000          R(N)=R(N)+DELH                                                     541
000710      000   C  ++++++ CALCULATE NEW CROSS-SECTIONAL AREA BASED ON HEAD INCREMENT ++++++
000711      000          A(N)=A(N)+B(N)*DELH                                                542
000712      000   840    CONTINUE                                                           543
000713      000   C      **************               END                   *************   544
000714      000   C                                                                         545
000715      000   C      ************** SHIFT THE NODAL ARRAYS              *************   546
000716      000          DO 850 J=1,NJ                                                      547
000717      000   850    H(J)=HN(J)                                                         548
000718      000   C      **************               END                   *************   549
000719      000   C                                                                         550
000720      000   C                                                                         551
000721      000   C      ************** STATEMENT 860 IS THE END OF ONE HYDRAULIC CYCLE ****   552
000722      000   860    CONTINUE                                                           553
000723      000   C      ******************************************************************   554
000724      000   C                                                                         555
000725      000   C      ************** AVERAGE THE FLOWS AND VELOCITIES     *************   556
000726      000   C      ************** FOR USE BY THE PRINTOUT AND SWQUAL   *************   557
000727      000   C  ++++++ IF NQSWRT DAILY CYCLES HAVE NOT ELAPSED, DO NOT BEGIN PRINTING ++
000728      000          IF (NT.LT.NQSWRT) GO TO 900                                        558
000729      000          DO 880 N=1,NC                                                      559
000730      000   C  ++++++ THE  AVERAGE  FLOW FOR THIS QUALITY  CYCLE ++++++
000731      000          QBAR(N)=QBAR(N)/FLOAT(NHCYC)                                       563
000732      000   C  ++++++ THE AVERAGE VELOCITY FOR THIS QUALITY CYCLE ++++++
000733      000          VBAR(N)=VBAR(N)/FLOAT(NHCYC)                                       564
000734      000   C  ++++++ QAVE = DAILY CYCLE AVERAGE FLOW ++++++
000735      000          QAVE(N)=QAVE(N)+QBAR(N)/FLOAT(NQCYC)                               565
000736      000   880    CONTINUE                                                           566
000737      000          DO 890 J=1,NJ                                                      567
```

```
 ******  HYDCAL  ******

000   C  ++++++ QUALITY CYCLE AVERAGE FLOW INTO THE NODE ++++++
000          QINBAR(J)=QINBAR(J)/FLOAT(NHCYC)
000   C  ++++++ QUALITY CYCLE AVERAGE FLOW OUT  OF  THE  NODE ++++++
000          QOUBAR(J)=QOUBAR(J)/FLOAT(NHCYC)
000   C  ++++++ AVERAGE  HEAD AT THE NODE DURING A QUALITY CYCLE ++++++
000          HBAR(J)=HBAR(J)/FLOAT(NHCYC)
000   C
000   C  ++++++ EVALUATE THE MAGNITUDE AND SIGN OF THE NET FLOW ++++++
000          IF (QINBAR(J).EQ.0.) GO TO 890
000          IF (QOUBAR(J).EQ.0.) GO TO 890
000          QINBAR(J)=QINBAR(J)-QOUBAR(J)
000          QOUNAR(J)=0.
000          IF (QINBAR(J).GT.0.) GO TO 890
000          QOUBAR(J)=-QINBAR(J)
000          QINBAR(J)=0.
000   C
000   890    CONTINUE
000   C      ***************              END                     *************
000   C
000   C      *************** WRITE OUT THE HYDRAULIC INFORMATION   *************
000   C      *************** FOR USE BY THE SWQUAL PROGRAM         *************
000          WRITE (N22) NT,NQ,(HBAR(J),VOL(J),QINBAR(J),QOUBAR(J),J=1,NJ),(QBA
000         1R(N),VBAR(N),N=1,NC)
000   C      ***************              END                     *************
000   C
000   C      *************** WRITE THE HYDRAULIC INFORMATION       *************
000   C      *************** TO FAST DRUM FOR LATER USE            *************
000   C      *************** BY THE PRINTING AND PLOT PROGRAM      *************
000          WRITE (N24) NT,NQ
000          WRITE (N24) (HBAR(J),J=1,NJ)
000          WRITE (N24) (VOL(J),J=1,NJ)
000          WRITE (N24) (QINBAR(J),J=1,NJ)
000          WRITE (N24) (QOUBAR(J),J=1,NJ)
000          WRITE (N24) (QBAR(N),N=1,NC)
000          WRITE (N24) (VBAR(N),N=1,NC)
000   C      ***************                 END                  *************
000   C
000   C      ************* STATEMENT  900 IS THE END OF ONE QUALITY CYCLE *****
000   900    CONTINUE
000   C      ******************************************************************
000   C
000   C
000   C      ************* STATEMENT  910 IS THE END OF ONE DAILY CYCLE********
000   910    CONTINUE
000   C      ******************************************************************
000   C
000   C
000   C
000          END FILE N22
000          REWIND N20
000          REWIND N22
000          READ (5,1020) IDECK
000          IF (IDECK.EQ.0) GO TO 1010
000          PUNCH 1030, (ALPHA(I),I=1,30)
000          EVAPM=EVAP/0.03937
000          WINDM=WIND/2.236
000          PUNCH 1040, NTCYC,PERIOD,QINT,DELT,EVAPM,WINDM,WDIR,NQSWRT,NJSW,
000         1NJGW,NTRIB
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BOTTOM OF IMAGE AREA; OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
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```
000        IF (NJSW.LE.0) GO TO 920
000        PUNCH 1050, (JSW(L),L=1,NJSW)
000   920  CONTINUE
000        PUNCH 1050, (JGW(L),L=1,NJGW)
000        IF (NTRIB.LE.0) GO TO 940
000        DO 930 I=1,NTRIB
000        PUNCH 1060, ITRIB(I,1),ITRIB(I,2)
000   930  CONTINUE
000   940  CONTINUE
000        DO 950 J=1,NJ
000        RAD=-DEP(J)
000        HAM=H(J)/3.28
000        AS(J)=ABS(AS(J))
000        ASM=AS(J)/10.744
000        QIM=QIN(J)/35.314
000        QOM=QOU(J)/35.314
000        RAM=-DEP(J)/3.28
000        PUNCH 1070, J,HAM,ASM,QIM,QOM,RAM,X(J),Y(J)
000   950  CONTINUE
000        PUNCH 1080
000        DO 1000 N=1,NC
000        IF (NTRIB.LE.0) GO TO 980
000        DO 960 IL=1,NTRIB
000        IF (ITRIB(IL,1).EQ.N) GO TO 970
000   960  CONTINUE
000        GO TO 980
000   970  IJN=ITRIB(IL,2)
000        RAD=0.5*(-DEP(IJN)-TRBDEP(IL))
000        GO TO 990
000   980  NH=NJUNC(N,1)
000        NL=NJUNC(N,2)
000        IF (NH.EQ.0) NH=NL
000        IF (NL.EQ.0) NL=NH
000        RAD=0.5*(-DEP(NL)-DEP(NH))
000   990  CONTINUE
000        AK(N)=ABS(AK(N))
000        B(N)=ABS(B(N))
000        NJUNC(N,1)=IABS(NJUNC(N,1))
000        NJUNC(N,2)=IABS(NJUNC(N,2))
000        LEN(N)=ABS(LEN(N))
000        RAD=RSAV(N)
000        AK(N)=SQRT(AK(N)*2.208196/32.1739)
000        LAM=LEN(N)/3.28
000        WAM=B(N)/3.28
000        RAM=RAD/3.28
000        VAM=V(N)/3.28
000        PUNCH 1090, N,NJUNC(N,1),NJUNC(N,2),LAM,WAM,RAM,AK(N),VAM
000  1000  CONTINUE
000        PUNCH 1080
000  1010  CONTINUE
000        WRITE (N6,1120)
000   C    **************           END           *************
000   C    **************           END           *************
000   C    **************           END           *************
000   C    **************           END           *************
000        RETURN
000   C
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```
 ******  HYDCAL   ******

000852      000    C                                                                         658
000853      000    C                                                                         659
000854      000    1020  FORMAT (I5)                                                         660
000855      000    1030  FORMAT (15A4)                                                       661
000856      000    1040  FORMAT (I5,3F5.0,5X,3F5.0,4I5)                                       662
000857      000    1050  FORMAT (2015)                                                       663
000858      000    1060  FORMAT (2I5)                                                        664
000859      000    1070  FORMAT (I5,F10.3,-6PF10.5,0P2F10.2,F10.2,5X,-3P2F10.3)           PEST
000860      000    1080  FORMAT (5H99999)                                                    666
000861      000    1090  FORMAT (3I5,10X,5F10.4)                                          PEST
000862      000    1100  FORMAT (33A4)                                                       668
000863      000     1110 FORMAT('0 V OVER 10 MPS, TIDAL CYCLE',I4,' QUAL CYCLE',I4,' HYDRO
000864      000            1 CYCLE',I4,' DEPTH',E10.4,'   V',E10.4,' CHANNEL',I5)            670
000865      000    1120  FORMAT (38H0COMPLETION OF THE HYDRAULIC PROGRAM  )                  671
000866      000          END

END ELT.

@HDG,P  ******  HYDPLT  ******
```

```
****** HYDPLT ******

@ELT,L HMAINT.HYDPLT

000          SUBROUTINE HYDPLT
000    C      THIS ROUTINE IS CALLED BY HMAINV (OR HMAINT)
000    C      AND CALLS FIND AND PICTO
000    C     *************** HYDRAULIC PROGRAM PRINTING            *************
000    C     *************** AND PLOTTING PROGRAM                  *************
000    C
000    C     *************** BATTELLE NORTHWEST 11/9/71            *************
000    C     ***********************************************************************
000    C
000    C
000    C     *************** ASSIGN THE COMMON  DATA               *************
000          COMMON /TAPES/N5,N6,N20,N22,N24
000          COMMON/PARAMS/IZ5,IZ6,IZ9,IZ12,IZ13
000    C
000    C     *************** CONTROL AND TITLE INFORMATION         *************
000          COMMON /PRINT/ NJ,NC,NTCYC,NQCYC,DELTQ,PERIOD,ALPHA(30),
000         1DEP(70),NQSWRT
000          COMMON/NT/NTP,NQP,DUM(600),HP(20,200),VOLP(20,200),TIMEP(200),
000         1QINP(20,200),QOUP(20,200),QP(20,200),VP(20,200),XX(400),YY(400),
000         2ARK(400),XYM(3,500)
000          DIMENSION ICH(6),SPACE(6),NJW(20),NCW(20),ISYM(5)
000          DIMENSION CARD1(66)
000          DIMENSION RUNTIT(20)
000          DATA STAR/1H*/,PERID/1H./,VEE/1HV/,QUU/1HQ/
000          DATA (SPACE(I),I=1,6)/6*1H /
000          DATA BLANK/1H /
000    C
000    C
000    C     *************** ASK THE USER WHICH INFORMATION        *************
000    C     *************** HE WISHES TO PRINT AND PLOT           *************
000    100   CONTINUE
000          READ (N5,450,END=110) RUNTIT
000          GO TO 120
000    110   RETURN
000    120   CONTINUE
000          READ (N5,510) IDAY1,IDAYL,NJP
000          IF (IDAY1.LE.0) IDAY1=1
000          IF (IDAY1.LT.NQSWRT) IDAY1=NQSWRT
000          IF (IDAYL.GT.NTCYC) IDAYL=NTCYC
000          IF ((IDAYL-IDAY1).GT.6) IDAYL=IDAY1+6
000          IF (IDAY1.GT.IDAYL) IDAYL=IDAY1
000          IF (NJP.GT.20) WRITE (N6,500)
000          NJP=MIN0(20,NJP)
000          READ (N5,520) (NJW(I),I=1,NJP)
000          READ (N5,530) NCP
000          IF (NCP.GT.20) WRITE (N6,540)
000          NCP=MIN0(20,NCP)
000          READ (N5,520) (NCW(I),I=1,NCP)
000          READ (N5,460) NPLOTS
000          WRITE (6,470) (RUNTIT(KITE),KITE=1,20)
000          WRITE (6,480) ALPHA
000          WRITE (N6,550) IDAY1,IDAYL,NJP,(NJW(I),I=1,NJP)
000          WRITE (N6,560) NCP,(NCW(I),I=1,NCP)
```

```
000           IF (NPLOTS.EQ.0) WRITE (6,490)
000     C     **************               END                   *************
000     C
000     C
000     C     ************** SEARCH FOR THE DESIRED TIME INTERVAL *************
000           REWIND N24
000     130   READ (N24) NTP,NQP
000           IF (NTP.GE.IDAY1) GO TO 140
000           READ (N24)
000           READ (N24)
000           READ (N24)
000           READ (N24)
000           READ (N24)
000           READ (N24)
000           GO TO 130
000     140   CONTINUE
000           DO 160 ND=IDAY1,IDAYL
000           DO 150 NQC=1,NQCYC
000           ILAST=(NTP-IDAY1)*NQCYC+NQP
000           TIMEP(ILAST)=(FLOAT((NTP-1)*NQCYC+NQP)-0.5)/FLOAT(NQCYC)
000           CALL FIND (ILAST,NJP,DUM,NJW,HP,NJ)
000           CALL FIND (ILAST,NJP,DUM,NJW,VOLP,NJ)
000           CALL FIND (ILAST,NJP,DUM,NJW,QINP,NJ)
000           CALL FIND (ILAST,NJP,DUM,NJW,QOUP,NJ)
000           CALL FIND (ILAST,NCP,DUM,NCW,QP,NC)
000           CALL FIND (ILAST,NCP,DUM,NCW,VP,NC)
000           IF ((ND.EQ.IDAYL).AND.(NQC.EQ.NQCYC)) GO TO 170
000           READ (N24) NTP,NQP
000     150   CONTINUE
000           IF (ND.EQ.IDAYL) GO TO 170
000     160   CONTINUE
000     C     **************               END                   *************
000     C
000     C
000     C     ************** WRITE OUT THE JUNCTION DATA TO PRINTER ************
000     170   CONTINUE
000           IWHOLE=NJP/3
000           IPART=NJP-IWHOLE*3
000           IF (IWHOLE.EQ.0) GO TO 210
000           DO 200 I=1,IWHOLE
000           IL=(I-1)*3
000           WRITE (6,470) (RUNTIT(KITE),KITE=1,20)
000           WRITE (6,480) ALPHA
000           DO 180 IK=1,3
000     180   ICH(IK)=NJW(IL+IK)
000           WRITE (N6,570) (SPACE(L),ICH(L),L=1,3)
000           WRITE (N6,580) (SPACE(L),L=1,3)
000           WRITE (N6,590) (SPACE(L),L=1,3)
000           DO 190 IDAY=IDAY1,IDAYL
000           IL1=IL+1
000           IL3=IL+3
000           ID=(IDAY-IDAY1)*NQCYC+1
000           IDL=ID-1+NQCYC
000           DO 188 I1=IL1,IL3
000           DO 188 L=ID,IDL
000           HP(I1,L)=HP(I1,L)/3.28
000           VOLP(I1,L)=VOLP(I1,L)/35.314
```

```
******   HYDPLT   ******

000111     000           QINP(I1,L)=QINP(I1,L)/35.314
000112     000     188   QOUP(I1,L)=QOUP(I1,L)/35.314
000113     000           WRITE(N6,600) IDAY
000114     000           WRITE(N6,610) (TIMEP(L),(HP(I1,L),VOLP(I1,L),QINP(I1,L),QOUP(I1,L)
000115     000          1,I1=IL1,IL3),L=ID,IDL)
000116     000           DO 189 I1=IL1,IL3
000117     000           DO 189 L=ID,IDL
000118     000           HP(I1,L)=HP(I1,L)*3.28
000119     000           VOLP(I1,L)=VOLP(I1,L)*35.314
000120     000           QINP(I1,L)=QINP(I1,L)*35.314
000121     000     189   QOUP(I1,L)=QOUP(I1,L)*35.314
000122     000    190    CONTINUE                                                          110
000123     000    200    CONTINUE                                                          111
000124     000           IF (IPART.LE.0) GO TO 260                                         112
000125     000    210    ILL=IWHOLE*3+IPART                                                113
000126     000           IL1=IWHOLE*3+1                                                    114
000127     000           DO 220 I=IL1,ILL                                                  115
000128     000           J=I-IL1+1                                                         116
000129     000    220    ICH(J)=NJW(I)                                                     117
000130     000           WRITE (6,470) (RUNTIT(KITE),KITE=1,20)                            118
000131     000           WRITE (6,480) ALPHA                                               119
000132     000           WRITE (N6,570) (SPACE(L),ICH(L),L=1,IPART)                        120
000133     000           WRITE (N6,580) (SPACE(L),L=1,IPART)                               121
000134     000           WRITE (N6,590) (SPACE(L),L=1,IPART)                               122
000135     000           DO 250 IDAY=IDAY1,IDAYL                                           123
000136     000           IL1=IWHOLE*3+1                                                    124
000137     000           ILL=IWHOLE*3+IPART                                                125
000138     000           ID=(IDAY-IDAY1)*NQCYC+1                                           126
000139     000           IDL=ID-1+NQCYC                                                    127
000140     000           WRITE(N6,600) IDAY
000141     000           GO TO (230,240), IPART                                            129
000142     000     230   CONTINUE
000143     000           DO 231 L=ID,IDL
000144     000           HP(IL1,L)=HP(IL1,L)/3.28
000145     000           VOLP(IL1,L)=VOLP(IL1,L)/35.314
000146     000           QINP(IL1,L)=QINP(IL1,L)/35.314
000147     000     231   QOUP(IL1,L)=QINP(IL1,L)/35.314
000148     000           WRITE(N6,620) (TIMEP(L),HP(IL1,L),VOLP(IL1,L),QINP(IL1,L),QOUP(IL1
000149     000          1,L),L=ID,IDL)
000150     000           DO 232 L=ID,IDL
000151     000           HP(IL1,L)=HP(IL1,L)*3.28
000152     000           VOLP(IL1,L)=VOLP(IL1,L)*35.314
000153     000           QINP(IL1,L)=QINP(IL1,L)*35.314
000154     000     232   QOUP(IL1,L)=QINP(IL1,L)*35.314
000155     000           GO TO 250                                                         132
000156     000    240    CONTINUE
000157     000           DO 241 I1=IL1,ILL
000158     000           DO 241 L=ID,IDL
000159     000           HP(I1,L)=HP(I1,L)/3.28
000160     000           VOLP(I1,L)=VOLP(I1,L)/35.314
000161     000           QINP(I1,L)=QINP(I1,L)/35.314
000162     000    241    QOUP(I1,L)=QOUP(I1,L)/35.314
000163     000           WRITE(N6,630) (TIMEP(L),(HP(I1,L),VOLP(I1,L),QINP(I1,L),QOUP(I1,L)
000164     000          1,I1=IL1,ILL),L=ID,IDL)
000165     000           DO 242 I1=IL1,ILL
000166     000           DO 242 L=ID,IDL
000167     000           HP(I1,L)=HP(I1,L)*3.28
```

```
000          VOLP(I1,L)=VOLP(I1,L)*35.314
000          QINP(I1,L)=QINP(I1,L)*35.314
000    242   QOUP(I1,L)=QOUP(I1,L)*35.314
000    250   CONTINUE
000    260   CONTINUE
000    C     ***************                  END                  **************
000    C
000    C
000    C     ************** WRITE OUT THE CHANNEL DATA TO THE PRINTER *********
000          IWHOLE=NCP/6
000          IPART=NCP-IWHOLE*6
000          IF (IWHOLE.EQ.0) GO TO 300
000          DO 290 I=1,IWHOLE
000          WRITE (6,470) (RUNTIT(KITE),KITE=1,20)
000          WRITE (6,480) ALPHA
000          IL=(I-1)*6
000          DO 270 IK=1,6
000    270   ICH(IK)=NCW(IL+IK)
000          WRITE (N6,640) (SPACE(L),ICH(L),L=1,6)
000          WRITE (N6,650) (SPACE(L),L=1,6)
000          WRITE (N6,660) (SPACE(L),L=1,6)
000          DO 280 IDAY=IDAY1,IDAYL
000          IL1=IL+1
000          IL3=IL+6
000          ID=(IDAY-IDAY1)*NQCYC+1
000          IDL=ID-1+NQCYC
000          DO 278 I1=IL1,IL3
000          DO 278 L=ID,IDL
000          QP(I1,L)=QP(I1,L)/35.314
000    278   VP(I1,L)=VP(I1,L)/3.28
000          WRITE(N6,600) IDAY
000          WRITE(N6,670) (TIMEP(L),(QP(I1,L),VP(I1,L),I1=IL1,IL3),L=ID,IDL)
000          DO 279 I1=IL1,IL3
000          DO 279 L=ID,IDL
000          QP(I1,L)=QP(I1,L)*35.314
000    279   VP(I1,L)=VP(I1,L)*3.28
000    280   CONTINUE
000    290   CONTINUE
000          IF (IPART.LE.0) GO TO 380
000    300   ILL=IWHOLE*6+IPART
000          IL1=IWHOLE*6+1
000          DO 310 I=IL1,ILL
000          J=I-IL1+1
000    310   ICH(J)=NCW(I)
000          WRITE (6,470) (RUNTIT(KITE),KITE=1,20)
000          WRITE (6,480) ALPHA
000          WRITE (N6,640) (SPACE(L),ICH(L),L=1,IPART)
000          WRITE (N6,650) (SPACE(L),L=1,IPART)
000          WRITE (N6,660) (SPACE(L),L=1,IPART)
000          DO 370 IDAY=IDAY1,IDAYL
000          ID=(IDAY-IDAY1)*NQCYC+1
000          IDL=ID-1+NQCYC
000          DO 318 I1=IL1,ILL
000          DO 318 L=ID,IDL
000          QP(I1,L)=QP(I1,L)/35.314
000    318   VP(I1,L)=VP(I1,L)/3.28
000          WRITE(N6,600) IDAY
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000          GO TO (320,330,340,350,360), IPART
000    320   CONTINUE
000          WRITE(N6,680) (TIMEP(L),(QP(I1,L),VP(I1,L),I1=IL1,ILL),L=ID,IDL)
000          GO TO 368
000    330   CONTINUE
000          WRITE(N6,690) (TIMEP(L),(QP(I1,L),VP(I1,L),I1=IL1,ILL),L=ID,IDL)
000          GO TO 368
000    340   CONTINUE
000          WRITE(N6,700) (TIMEP(L),(QP(I1,L),VP(I1,L),I1=IL1,ILL),L=ID,IDL)
000          GO TO 368
000    350   CONTINUE
000          WRITE(N6,710) (TIMEP(L),(QP(I1,L),VP(I1,L),I1=IL1,ILL),L=ID,IDL)
000          GO TO 368
000    360   CONTINUE
000          WRITE(N6,720) (TIMEP(L),(QP(I1,L),VP(I1,L),I1=IL1,ILL),L=ID,IDL)
000     368  CONTINUE
000          DO 369 I1=IL1,ILL
000          DO 369 L=ID,IDL
000          QP(I1,L)=QP(I1,L)*35.314
000     369  VP(I1,L)=VP(I1,L)*3.28
000    370   CONTINUE
000    380   CONTINUE
000    C     **************               END                **************
000    C
000    C
000    C     ************** CALCULATE THE NUMBER OF POINTS TO BE PLOTTED ******
000          IF (NPLOTS.EQ.0) GO TO 100
000          NPOINT=(IDAYL-IDAY1+1)*NQCYC
000    C     **************             END                  **************
000    C
000    C     ************** SET UP THE SYMBOL PRIORITIES FOR PICTUR ***********
000          DO 390 I=1,4
000    390   ISYM(I)=STAR
000          ISYM(5)=BLANK
000    C     **************             END                  **************
000    C
000    C
000    C     ************** SET UP THE OUTER DO LOOP FOR THE JUNCTION PLOTS ***
000          DO 410 J=1,NJP
000    C
000    C     ************** SET UP THE ARRAYS AND ALPHA NECESSARY ************
000    C     **************   FOR THE PICTUR SUBROUTINE          ************
000          IJUNC=NJW(J)
000          HMAX=0.
000          DO 400 K=1,NPOINT
000          XX(K)=TIMEP(K)
000          YY(K)=HP(J,K)
000          HMAX=AMAX1(HMAX,ABS(HP(J,K)))
000    400   ARK(K)=STAR
000          XX(NPOINT+1)=XX(NPOINT)
000          XX(NPOINT+2)=XX(NPOINT)
000          YY(NPOINT+1)=1.5*HMAX
000          YY(NPOINT+2)=-1.5*HMAX
000          ARK(NPOINT+1)=BLANK
000          ARK(NPOINT+2)=BLANK
000          NPOIN=NPOINT+2
000          DO 405 IJI=1,NPOIN
```

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```
******   HYDPLT   ******

000282      000    405  YY(IJI)=YY(IJI)/3.28
000283      000   C     **************               END                  *************     230
000284      000   C                                                                          231
000285      000         ENCODE (53,730,CARD1) IJUNC
000286      000         ENCODE (45,740,CARD1(34)) IJUNC
000287      000         CALL PICTO (NPOIN,25,50,ISYM,CARD1,RUNTIT)                           232
000288      000   410   CONTINUE                                                             233
000289      000   C     **************               END                  *************     234
000290      000   C                                                                          235
000291      000   C     ************** SET UP THE SYMBOL PRIORITIES FOR PICTUR ***********   236
000292      000         ISYM(1)=STAR                                                         237
000293      000   C     **************               END                  *************     238
000294      000   C                                                                          239
000295      000   C                                                                          240
000296      000   C     ************** SET UP THE OUTER DO LOOP FOR THE CHANNEL PLOTS ****   241
000297      000         DO 440 J=1,NCP                                                       242
000298      000   C     ************** SEARCH FOR QMAX AND VMAX         *************       243
000299      000         QMAX=0.0                                                             244
000300      000         DO 420 I=1,NPOINT                                                    245
000301      000         QMAX=AMAX1(ABS(QP(J,I)),QMAX)                                        246
000302      000   420   CONTINUE                                                             247
000303      000   C     **************           END                      *************     248
000304      000   C                                                                          249
000305      000   C     ************** SET UP THE ARRRAYS AND ALPHA NECESSARY ************  250
000306      000   C     **************   FOR THE PICTUR SURROUTINE         ************     251
000307      000         ICHN=NCW(J)                                                          252
000308      000         DO 430 K=1,NPOINT                                                    253
000309      000         YY(K)=QP(J,K)/1000.                                                  254
000310      000         ARK(K)=STAR                                                          255
000311      000   430   CONTINUE                                                             256
000312      000         YY(NPOINT+1)=1.50*QMAX/1000.                                         257
000313      000         YY(NPOINT+2)=-1.50*QMAX/1000.                                        258
000314      000         IN=NPOINT+2
000315      000         DO 435 I=1,IN
000316      000    435  YY(I)=YY(I)/35.314
000317      000   C                                                                          261
000318      000   C     **************               END                  *************     262
000319      000   C                                                                          263
000320      000         ENCODE (53,750,CARD1) ICHN
000321      000         ENCODE (47,760,CARD1(34)) ICHN
000322      000         CALL PICTO (NPOIN,25,50,ISYM,CARD1,RUNTIT)                           264
000323      000   440   CONTINUE                                                             265
000324      000   C     **************           END                      *************     266
000325      000   C                                                                          267
000326      000   C                                                                          268
000327      000         GO TO 100                                                            269
000328      000   C     **************               END                  *************     270
000329      000   C                                                                          271
000330      000   C                                                                          272
000331      000   C                                                                          273
000332      000   450   FORMAT (20A4)                                                        274
000333      000   460   FORMAT (I5)                                                          275
000334      000   470   FORMAT (1H1,25X,20A4)                                                276
000335      000   480   FORMAT (1H0,15A4,20X,20HBATTELLE NORTHWEST  ,/1X,15A4,19X,21H RICH   277
000336      000        1LAND, WASHINGTON,/,81X,20HEXPLORE-1 CODE      ,/81X,20HHYDRODYNAMI   278
000337      000        2C MODEL  ,/)                                                         279
000338      000   490   FORMAT (' AS REQUESTED THE PLOTS WILL BE SUPPRESSED.')               280
```

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```
******   HYDPLT   ******

      000    500   FORMAT (' YOU CANNOT MONITOR MORE THAN 20 NODES AT ONE TIME '/)
      000    510   FORMAT (2I10,/I10)
      000    520   FORMAT (20I4)
      000    530   FORMAT (I10)
      000    540   FORMAT (' YOU CANNOT MONITOR MORE THAN 20 CHANNELS AT ONE TIME '/)
      000    550   FORMAT (1H0,'FOR WHAT SPAN OF DAYS DO YOU WISH LINEPRINTER AND PLO
      000         1T INFORMATION'/' I WISH TO LOOK AT THE DATA STARTING WITH DAY',I5,
      000         2' AND ENDING WITH DAY',I5,//' HOW MANY NODAL POINTS DO YOU WISH TO
      000         3 MONITOR'/' I WISH TO MONITOR ',I5,' NODES'//' FOR WHICH NODES DO
      000         4 YOU WISH LINEPRINTER AND PLOT INFORMATION'/' I WISH TO MONITOR TH
      000         5E FOLLOWING NODES '/20I5,/20I5)
      000    560   FORMAT (//,' HOW MANY CHANNELS DO YOU WISH TO MONITOR '/' I WISH T
      000         1O MONITOR ',I5,' CHANNELS '//' FOR WHICH CHANNELS DO YOU WISH LINE
      000         2PRINTER AND PLOT INFORMATION '/' I DESIRE PLOT AND LINEPRINTER INF
      000         3ORMATION FOR THE FOLLOWING CHANNELS '/20I5/20I5)
      000     570  FORMAT(22X,A1,'JUNCTION',I4,A1,27X,'JUNCTION',I4,A1,27X,'JUNCTION'
      000         $,I4,/)
      000    580   FORMAT(6X,A1,'TIME',4X,'HEAD',6X,'VOLUME',4X,'INFLOW',3X,'OUTFLOW'
      000         $,A1,3X,'HEAD',6X,'VOLUME',4X,'INFLOW',3X,'OUTFLOW',A1,3X,'HEAD',6X
      000         $,'VOLUME',4X,'INFLOW',3X,'OUTFLOW')
      000    590   FORMAT(5X,A1,'(DAYS)    (M)        (M**3)      (CMS)     (CMS)',A1,'
      000         $  (M)        (M**3)      (CMS)     (CMS)',A1,'     (M)        (M**3)
      000         $  (CMS)     (CMS)')
      000    600   FORMAT (1H0,11HDAY NUMBER ,I4,/)
      000    610   FORMAT (1PE12.4,2E11.4,2E9.2,2E11.4,2E9.2,2E11.4,2E9.2)
      000    620   FORMAT (1PE12.4,2E11.4,2E9.2)
      000    630   FORMAT (1PE12.4,2E11.4,2E9.2,2E11.4,2E9.2)
      000    640   FORMAT (1H0,16X,A1,8HCHANNEL ,I4,A1,7X,8HCHANNEL ,I4,A1,7X,8HCHANN
      000         1EL ,I4,A1,7X,8HCHANNEL ,I4,A1,7X,8HCHANNEL ,I4,A1,7X,8HCHANNEL ,I4
      000         2)
      000    650   FORMAT (7X,A1,4HTIME,18H     FLOW VELOCITY,A1,19H      FLOW VELOCI
      000         1TY,A1,19H      FLOW VELOCITY,A1,19H      FLOW VELOCITY,A1,19H
      000         2 FLOW VELOCITY,A1,19H      FLOW VELOCITY)
      000     660  FORMAT(5X,A1,'(DAYS)     (CMS)  (M/SEC)',A1,'      (CMS)  (M/SEC)',
      000         1A1,'      (CMS)  (M/SEC)',A1,'      (CMS)  (M/SEC)',A1,'      (CMS)
      000         2(M/SEC)',A1,'      (CMS)  (M/SEC)')
      000    670   FORMAT (E12.4,2E9.3,2X,2E9.3,2X,2E9.3,2X,2E9.3,2X,2E9.3,2X,2E9.3)
      000    680   FORMAT (E12.4,2E9.3)
      000    690   FORMAT (E12.4,2E9.3,2X,2E9.3)
      000    700   FORMAT (E12.4,2E9.3,2X,2E9.3,2X,2E9.3)
      000    710   FORMAT (E12.4,2E9.3,2X,2E9.3,2X,2E9.3,2X,2E9.3)
      000    720   FORMAT (E12.4,2E9.3,2X,2E9.3,2X,2E9.3,2X,2E9.3,2X,2E9.3)
      000    730   FORMAT (' PLOT OF THE HEAD VERSUS TIME CURVE FOR JUNCTION ',I4)
      000     740  FORMAT(' (HEAD IS IN METERS AND THE TIME IS IN DAYS) ')
      000    750   FORMAT (' PLOT OF THE FLOW VERSUS TIME CURVE FOR CHANNEL',I4,'  ')
      000     760  FORMAT('  FLOW IN (THOUSANDS OF CMS) AND TIME IN (DAYS)')
      000          END

END ELT.
```

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```
******  MAIN  ******

@ELT,L HMAINT.MAIN

000001     000   C      MAIN PROGRAM TO COORDINATE THE CALCULATION AND PLOTTING PROGRAM
000002     000   C      THIS PROGRAM CALLS HYDCAL AND HYDPLT
000003     000   C     SCRATCH UNITS ARE SCRATCH TAPES                                        2
000004     000   C
000005     000   C
000006     000   C         THIS EXECUTIVE PROGRAM MAKES I/O ASSIGNMENTS AND CALLS THE
000007     000   C              CALCULATION SUBROUTINE HYDCAL AND THE PRINT-PLOT
000008     000   C              PROGRAM HYDPLT
000009     000   C
000010     000   C
000011     000         COMMON /TAPES/N5,N6,N20,N22,N24                                        3
000012     000         COMMON/PARAMS/IZ5,IZ6,IZ9,IZ12,IZ13                                    4
000013     000   C                                                                            5
000014     000         N5=5                                                                   6
000015     000         N6=6                                                                   7
000016     000   C                                                                            8
000017     000         IZ5=70
000018     000         IZ6=6                                                                 10
000019     000         IZ9=100
000020     000         IZ12=20                                                               12
000021     000         IZ13=20                                                               13
000022     000         N20=2                                                                 14
000023     000         N22=N20                                                               15
000024     000         N24=4
000025     000         REWIND N20                                                            17
000026     000         REWIND N22                                                            18
000027     000         REWIND N24                                                            19
000028     000   C
000029     000         CALL HYDCAL                                                           20
000030     000   C
000031     000         CALL HYDPLT                                                           21
000032     000   C
000033     000         STOP                                                                  22
000034     000         END                                                                    -

END ELT.

@HDG,P  ******  PICTO  ******
```

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```
****** PICTO ******

@ELT,L HMAINT.PICTO

000          SUBROUTINE PICTO (N,M,MCOL,ISYM,CARD1,RUNTIT)
000     C     THIS ROUTINE IS CALLED BY HYDPLT AND CALLS SORT
000     C    PROGRAMMED BY JE SCHLOSSER  1965  MODIFIED BY CA OSTER  1966
000     C    PRESENTS A PICTURE OF DATA ON PRINTED OUTPUT, TWO OPTIONS BEING     2
000     C    AVAILABLE                                                             3
000     C       1   MCOL POSITIVE                                                  4
000     C       2   MCOL NEGATIVE, IN WHICH CASE XINCREMENTS ARE TAKEN AS EQUAL   5
000     C           TO Y INCREMENTS AS DETERMINED BY M                             6
000     C                                                                          7
000     C    DICTIONARY                                                            8
000     C                                                                          9
000     C       VARIABLE   DEFINITION                                             10
000     C          N       NUMBER OF POINTS TO PLOT      (MAXIMUM OF 500)         11
000     C          M       MAXIMUM NUMBER OF LINES                                12
000     C        MCOL      MAXIMUM NUMBER OF COLUMNS                              13
000     C                                                                         14
000     C        XX(I)     X COORDINATE FOR ITH POINT                             15
000     C        YY(I)     Y COORDINATE FOR ITH POINT                             16
000     C        ARK(I)    MARKER FOR ITH POINT                                   17
000     C        ISYM(I)   PRIORITY DESIGNATOR FOR MARKER USED ON I-TH POINT      18
000     C                       (LOWER SUBSCRIPT INDICATES HIGHER PRIORITY)       19
000     C                                                                         20
000     C                                                                         21
000     C    ************** BATTELLE NORTHWEST 11/9/71            *************   22
000     C    ****************************************************************   23
000     C                                                                         24
000     C                                                                         25
000     C    ************** ASSIGN THE COMMON  DATA               *************   26
000          COMMON /TAPES/N5,N6,N20,N22,N24                                      27
000          COMMON/PARAMS/IZ5,IZ6,IZ9,IZ12,IZ13                                  28
000     C                                                                         29
000     C    ************** CONTROL AND TITLE INFORMATION         *************   30
000          COMMON /PRINT/ NJ,NC,NTCYC,NOCYC,DFLTQ,PERIOD,ALPHA(30),             31
000         1DEP(70),NOSWRT                                                        32
000          COMMON/NT/NTP,NOP,DUM(600),HP(20,200),VOLP(20,200),TIMEP(200),
000         1QINP(20,200),QOUP(20,200),QP(20,200),VP(20,200),XX(400),YY(400),
000         2ARK(400),XYM(3,500)
000          DIMENSION IXYM(3,500)
000          EQUIVALENCE (IXYM,XYM)                                               37
000          DIMENSION PX(6),ALF(107),ILF(107),ISYM(5)                            38
000          DIMENSION CARD1(66)                                                  39
000          DIMENSION RUNTIT(20)
000          EQUIVALENCE (ILF,ALF),(BLANK,LANKBA)                                 41
000          EXTERNAL SORDER                                                      42
000     C                                                                         46
000          DATA BLANK/1H  /                                                     43
000     C                                                                         44
000          KILL=0                                                               45
000          N=MAX0(MIN0(500,N),2)                                                47
000          XYM(1,2)=1.01                                                        48
000          XYM(2,2)=1.01                                                        49
000          XYM(3,2)=BLANK                                                       50
000          XMIN=1.0E37                                                          51
                                                                                  52
```

```
 000            XMAX=-1.0F37
 000            DO 100 I=1,N
 000            XYM(1,I)=XX(I)
 000            XYM(2,I)=YY(I)
 000            XYM(3,I)=ARK(I)
 000            XMIN=AMIN1(XMIN,XYM(1,I))
 000            XMAX=AMAX1(XMAX,XYM(1,I))
 000     100    CONTINUF
 000            CALL SOPT (XYM,N,3,SORDER)
 000            YMIN=XYM(2,N)
 000            YMAX=XYM(2,1)
 000            DYLOG=ALOG10((YMAX-YMIN)/FLOAT(M)*1.0E5)
 000            APROX=DYLOG-AINT(DYLOG)
 000            DO 110 I=2,10
 000            FI=I
 000            IF (APROX-ALOG10(FI)) 120,120,110
 000     110    CONTINUE
 000     120    EXACT=FI*10.0**(INT(DYLOG)-5)
 000     130    IF (MCOL) 200,140,140
 000     140    DXLOG=ALOG10((XMAX-XMIN)/FLOAT(MCOL/2)*1.0E5)
 000            XAPROX=DXLOG-AINT(DXLOG)
 000            IF (XAPROX-.3010) 150,150,160
 000     150    XEXACT=2.0*10.0**(INT(DXLOG)-5)
 000            GO TO 190
 000     160    IF (XAPPOX-.6990) 170,170,180
 000     170    XEXACT=5.0*10.0**(INT(DXLOG)-5)
 000            GO TO 190
 000     180    XEXACT=10.0**(INT(DXLOG)-4)
 000     190    CONTINUE
 000            XACT=XEXACT/2.0
 000            GO TO 210
 000     200    XACT=EXACT/2.0
 000     210    TENX=20.0*XACT
 000            TENE=10.0*EXACT
 000            MAXYI=(YMAX/TENE)+(0.5+SIGN(0.5,YMAX))
 000            MAXXI=(XMAX/TENX)+(0.5+SIGN(0.5,XMAX))
 000            MINYI=(YMIN/TENE)-(0.5+SIGN(0.5,-YMIN))
 000            MINXI=(XMIN/TENX)-(0.5+SIGN(0.5,-XMIN))
 000            YFIRST=TENE*FLOAT(MAXYI)
 000            XFIRST=TENX*FLOAT(MINXI)
 000            LINES=10*(MAXYI-MINYI)+1
 000            KOLS=20*(MAXXI-MINXI)
 000            IF (KOLS-500) 230,230,220
 000     220    WRITF (6,530) KOLS
 000            KOLS=500
 000     230    IF (LINES-401) 250,250,240
 000     240    WRITE (6,540)
 000            RETURN
 000     250    CONTINUF
 000            KILL=KILL+1
 000            IF (KILL.GT.500) GO TO 260
 000            IF (KOLS.GE.75) GO TO 260
 000            MCOL=MCOL+1
 000            GO TO 130
 000     260    LEAF=(KOLS+99)/100
 000            IF (LEAF.LE.1) GO TO 270
 000            MCOL=MCOL-1
```

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```
******  PICTO  ******

000111      000         GO TO 130
000112      000   270   DO 450 L=1,LEAF
000113      000         DO 280 I=1,6
000114      000         PX(I)=5.*TENX*FLOAT(L-1)+TENX*FLOAT(I-1)+XFIRST
000115      000   280   CONTINUE
000116      000         WRITE (6,470) (RUNTIT(KITE),KITE=1,20)
000117      000         WRITE (6,460) ALPHA
000118      000         WRITE (6,480) (CARD1(ISTAT),ISTAT=1,66)
000119      000         WRITE (6,520) PX
000120      000         WRITE (6,510)
000121      000         DEX=XACT/2.0
000122      000         DEL=EXACT/2.0
000123      000         DDD=DEX+2.0*XACT
000124      000         J=1
000125      000         DO 440 I=1,LINES
000126      000         YPLOT=YFIRST-EXACT*FLOAT(I-1)
000127      000         DO 290 JKL=1,107
000128      000   290   ALF(JKL)=BLANK
000129      000   300   IF (J-N) 310,310,400
000130      000   310   IF (XYM(1,J)-PX(1)) 390,320,320
000131      000   320   CONTINUE
000132      000         IF (XYM(2,J)-(YPLOT+DEL)) 330,330,400
000133      000   330   IF (XYM(2,J)-(YPLOT-DEL)) 400,340,340
000134      000   340   CONTINUE
000135      000         IF (XYM(1,J)-PX(6)-DDD) 350,350,390
000136      000   350   CONTINUE
000137      000         KOL=INT((XYM(1,J)+DEX-PX(1))/XACT)+4
000138      000         IF ((KOL.GT.107).OR.(KOL.LT.1)) GO TO 390
000139      000         IXYM3J=IXYM(3,J)
000140      000         ILFKOL=ILF(KOL)
000141      000         IF (ILFKOL.EQ.LANKBA) GO TO 380
000142      000         ISYM1=0
000143      000         ISYM2=0
000144      000         DO 360 IIYY=1,5
000145      000         IF (ILFKOL.EQ.ISYM(IIYY)) ISYM1=IIYY
000146      000         IF (IXYM3J.EQ.ISYM(IIYY)) ISYM2=IIYY
000147      000   360   CONTINUE
000148      000         ISYMM=MIN0(ISYM1,ISYM2)
000149      000         IF (ISYMM) 390,390,370
000150      000   370   ILF(KOL)=ISYM(ISYMM)
000151      000         GO TO 390
000152      000   380   ALF(KOL)=XYM(3,J)
000153      000   390   J=J+1
000154      000         GO TO 300
000155      000   400   CONTINUE
000156      000         IF (MOD(I-1,10).NE.0) GO TO 410
000157      000         WRITE (6,490) YPLOT,ALF
000158      000         GO TO 430
000159      000   410   IF (MOD(I-1,5).NE.0) GO TO 420
000160      000         WRITE(6,550) ALF
000161      000         GO TO 430
000162      000   420   WRITE (6,500) ALF
000163      000   430   CONTINUE
000164      000   440   CONTINUE
000165      000         WRITE (6,510)
000166      000         WRITE (6,520) PX
000167      000   450   CONTINUE
```

```
****** PICTO ******

000168        000          RETURN                                                             167
000169        000    C                                                                        168
000170        000    C                                                                        169
000171        000    C                                                                        170
000172        000    460    FORMAT (1H0,15A4,20X,20HBATTELLE NORTHWEST  ,/1X,15A4,19X,21H RICH  171
000173        000          1LAND, WASHINGTON,/,81X,20HEXPLORE-1 CODE      ,/81X,20HHYDRODYNAMI  172
000174        000          2C MODEL  ,/)                                                      173
000175        000    470    FORMAT (1H1,25X,20A4)                                             174
000176        000    480    FORMAT (1H0,//33A4,/33A4///)
000177        000    490    FORMAT (1X,F9.3,2H *,107A1,1H*)                                   176
000178        000    500    FORMAT (11X,1HI,107A1,1HI)                                        177
000179        000    510    FORMAT (1H0,14X,1H*,    5(20H - - - - + - - - - *),/,1H )          178
000180        000    520    FORMAT (11X,F7.2,5(13X,F7.2))                                     179
000181        000    530    FORMAT (48H0ONLY THE FIRST 500 COLUMNS OF A PLOT REQUIRING I3,25H  180
000182        000          1COLUMNS WILL BE PRINTED.)                                         181
000183        000     540   FORMAT(1X,'THERE IS A LIMIT OF 400 LINES')
000184        000    550    FORMAT (11X,1H+,107A1,1H+)                                        184
000185        000           END
000186        000
000187        000

END ELT.

@HDG.P  ******  SORDER  ******
```

```
****** SORDER ******

@ELT,L HMAINT.SORDER

000001        000          FUNCTION SORDER (FIRST,SECOND)
000002        000    C      THIS FUNCTION IS CALLED BY SORT
000003        000          DIMENSION FIRST(3),SECOND(3)
000004        000          SORDER=FIRST(2)-SECOND(2)
000005        000          RETURN
000006        000          END

END ELT.

@HDG,P   ******   SORT   ******
```

```
****** SORT ******

@ELT,L HMAINT.SORT

000          SUBROUTINE SORT (M,N,ITEM,Q)
000     C     THIS ROUTINE IS CALLED BY PICTUR AND CALLS Q AND SORDER
000     C
000     C    ALGORITHM 245 -  TREESORT 3   FROM ACM, DEC. 1964
000     C                                 VOL 7   NUMBER 12, PAGE 701
000     C
000     C    PROGRAMMED BY JE SCHLOSSER
000     C
000     C
000     C    GENERAL PURPOSE INTERNAL SORT SUBROUTINE
000     C
000     C    EXAMPLE OF USE - - -    ASSUME -   N ITEMS OF 5 WORDS EACH
000     C                                       TO BE SORTED IN ASCENDING
000     C                                       ORDER ON THE SECOND WORD.
000     C    MAIN PROGRAM
000     C    DIMENSION A(5,1000)    N IS LESS THAN OR EQUAL TO 1000
000     C                           A CONTAINS THE ITEMS TO BE SORTED
000     C
000     C    EXTERNAL Q        Q IS A FUNCTION SUBROUTINE WHICH WILL RETURN
000     C     .                A POSITIVE NUMBER IF THE FIRST ITEM (FIRST
000     C     .                ARGUMENT) IS TO SORT AHEAD OF THE  SECOND
000     C     .                ITEM (SECOND ARGUMENT).   SEE EXAMPLE BELOW.
000     C
000     C    CALL SORT (A,N,5,Q)    ARGUMENT    MEANING
000     C     .                      FIRST      ARRAY CONTAINING ITEMS
000     C     .                      SECOND     NUMBER OF ITEMS
000     C     .                      THIRD      NUMBER OF WORDS PER ITEM
000     C     .                      FOURTH     FUNCTION SUBROUTINE TO
000     C     .                                        DEFINE SORT ORDER
000     C
000     C    FUNCTION Q(B,C)          WRITE A FUNCTION SUBROUTINE SUCH AS THIS.
000     C    DIMENSION B(5),C(5)      IT SHOULD RETURN A POSITIVE RESULT IF
000     C    Q=C(2)-B(2)              THE FIRST ARGUMENT SHOULD SORT AHEAD
000     C    RETURN                   OF THE SECOND ARGUMENT.  THIS ROUTINE
000     C    END                      PRODUCES AN ASCENDING SORT ON THE SECOND
000     C                             WORD  OF THE ITEMS.
000     C
000     C    NOTE - -  THE MAXIMUM NUMBER OF WORDS PER ITEM IS LIMITED
000     C    BY THE DIMENSION OF KOPY.     THIS LIMIT IS PRESENTLY 100.
000     C
000     C    APPROXIMATE SPEED IS 250 ITEMS PER SECOND.
000          INTEGER Q
000          DIMENSION KOPY (100)
000          DIMENSION M(ITEM,N)
000          IF (N-1) 320,320,100
000     100  K=N/2+1
000          L=N/2-1
000          IF (L) 210,210,110
000     110  CONTINUE
000          DO 200 II=1,L
000          I=K-II
000          IS=I
000          NS=N
```

```
******  SORT  ******

000054      000           DO 120 IQ=1,ITEM                                           53
000055      000     120   KOPY(IQ)=M(IQ,IS)                                          54
000056      000     130   J=2*IS                                                     55
000057      000           IF (J.GT.NS) GO TO 180                                     56
000058      000           IF (J.GE.NS) GO TO 150                                     57
000059      000           IF (Q(M(1,J+1),M(1,J))) 140,150,150                        58
000060      000     140   J=J+1                                                      59
000061      000     150   IF (Q(M(1,J),KOPY)) 160,180,180                            60
000062      000     160   DO 170 IQ=1,ITEM                                           61
000063      000     170   M(IQ,IS)=M(IQ,J)                                           62
000064      000           IS=J                                                       63
000065      000           GO TO 130                                                  64
000066      000     180   DO 190 IQ=1,ITEM                                           65
000067      000     190   M(IQ,IS)=KOPY(IQ)                                          66
000068      000     200   CONTINUE                                                   67
000069      000     210   NPLUS=N+2                                                  68
000070      000           DO 310 II=2,N                                              69
000071      000           I=NPLUS-II                                                 70
000072      000           IS=1                                                       71
000073      000           NS=I                                                       72
000074      000           DO 220 IQ=1,ITEM                                           73
000075      000     220   KOPY(IQ)=M(IQ,IS)                                          74
000076      000     230   J=2*IS                                                     75
000077      000           IF (J.GT.NS) GO TO 280                                     76
000078      000           IF (J.GE.NS) GO TO 250                                     77
000079      000           IF (Q(M(1,J+1),M(1,J))) 240,250,250                        78
000080      000     240   J=J+1                                                      79
000081      000     250  'IF (Q(M(1,J),KOPY)) 260,280,280                            80
000082      000      260   DO 270 IQ=1,ITEM                                          81
000083      000     270   M(IQ,IS)=M(IQ,J)                                           82
000084      000           IS=J                                                       83
000085      000           GO TO 230                                                  84
000086      000     280   DO 290 IQ=1,ITEM                                           85
000087      000     290   M(IQ,IS)=KOPY(IQ)                                          86
000088      000           DO 300 IT=1,ITEM                                           87
000089      000           LAZY=M(IT,1)                                               88
000090      000           M(IT,1)=M(IT,I)                                            89
000091      000           M(IT,I)=LAZY                                               90
000092      000     300   CONTINUE                                                   91
000093      000     310   CONTINUE                                                   92
000094      000     320   CONTINUE                                                   93
000095      000           RETURN                                                     94
000096      000           END                                                        -

END ELT.
```